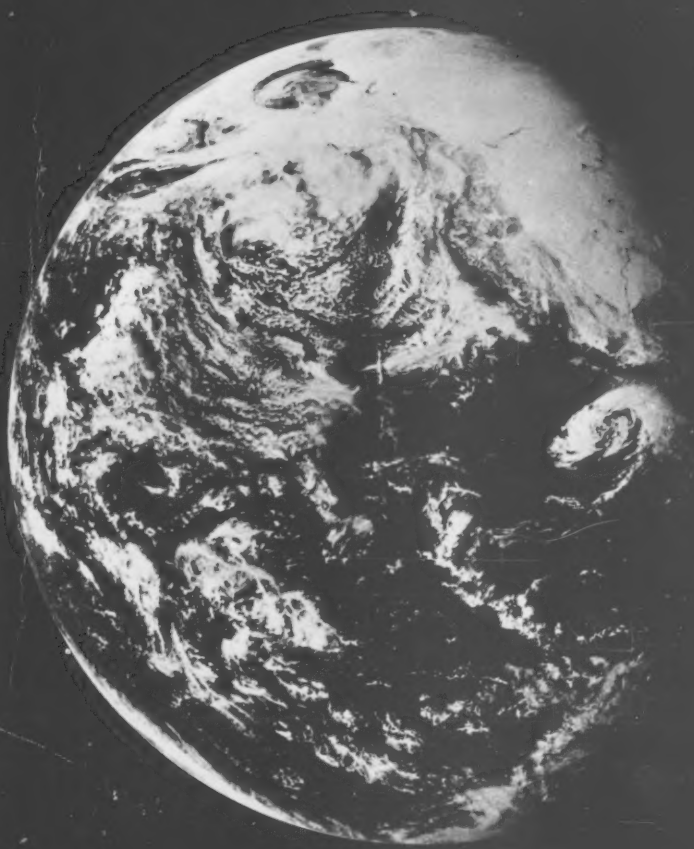
ENVIRONMENTAL QUALITY

The Tenth
Annual Report
of the Council on
Environmental Quality



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ENVIRONMENTAL QUALITY–1979

The Tenth Annual Report
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December 1979

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THE PRESIDENT'S MESSAGE

To the Congress of the United States:

I am pleased to transmit to the Congress the Tenth Annual Report of the Council on Environmental Quality. This report reflects the solid achievement of a decade of intensive effort by the American people and their government to improve the quality of the environment.

Of all the social, political, and economic changes of the past decade, perhaps none is more important to the future of our planet and the survival of our children than the change that has taken place in the way we look at our world and its resources. In the past 10 years, we have come to understand that our own well-being and the health, the safety—indeed the existence—of future generations depend on how we treat our world today. We know now that our planet is both fragile and finite, and that the decisions we make today will spell the difference between a polluted, unproductive, and eventually uninhabitable world, and a world that can sustain itself and the creatures that live on it indefinitely.

This change in our collective consciousness was not only remarkably swift, but also remarkably broad. People around the world simultaneously began to realize the dangers of pollution and the hazards of abusing and depleting the earth's resources, and to demand effective action to protect the environment.

In the United States, a decade of environmental progress began with the signing on January 1, 1970 of the National Environmental Policy Act—the nation's charter for protecting and improving the environment. The first Earth Day, in April 1970, showed unmistakably the nation's new environmental awareness. Millions of people across the country participated in teach-ins, clean-ups, and many other actions to demonstrate their environmental concern and to gain a greater appreciation of ecology. The active citizen involvement in environmental affairs spurred by Earth Day has been the major force behind the accomplishments of the past 10 years. Public support for an improved, healthy environment remains strong as we enter the 1980s.

The environmental record of the Congress and the Executive Branch during these 10 years has been exceptional. Congress has passed more than two dozen pieces of landmark legislation designed to preserve or enhance environmental quality—an unprecedented

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record of accomplishment in just one decade. Several of these laws were measures I proposed and strongly supported. I have personally had the pleasure of signing into law the 1977 amendments to the Clean Air Act and the Clean Water Act, the 1977 Surface Mining Control and Reclamation Act, the 1977 Mine Safety and Health Act, the 1977 Nuclear Non-Proliferation Act, the 1978 National Energy Act, with its many features emphasizing energy conservation, the 1978 Environmental Pesticide Control Act, the 1978 Quiet Communities Act, the 1978 National Parks and Recreation Act, and the reauthorization of such essential laws as the Endangered Species Act. I have also had the satisfaction of issuing two broad Environmental Messages that initiated more than 100 legislative proposals, Executive orders and directives, and policy reforms.

The Administration and the Congress have not yet accomplished all of the environmental goals that I have set, but we have done a great deal in three years and will continue our efforts. The actions my administration has taken to protect the environment here and abroad, and the successes we have had, are among the most gratifying achievements of my Presidency.

The sustained environmental improvement effort of the past 10 years has made significant inroads on the problems identified at the start of the decade. Most major industrial facilities have met initial air and water pollution control requirements. Automobiles are now equipped with pollution control devices. The environmental achievements of state and local governments and of many other nations and international organizations are impressive.

The fact that our nation has accomplished much in so short a time does not mean that we can relax our vigilance. Many serious environmental problems remain unsolved. One of the most troublesome examples during the past year was the seepage of toxic chemicals from an abandoned waste dump at Love Canal in Niagara Falls, N.Y., creating a public health problem of major proportions. Incidents like Love Canal make painfully clear the continued need for environmental protection programs. The past year has also reminded us again of the environmental dangers of complicated technologies that we do not fully understand or control, and of the need to manage the earth's finite resources, such as energy and food, in better ways. In the years ahead, solving environmental problems does not promise to become easier.

We are, however, better equipped to deal with the problems of the future than we were in 1970. This February marks the 10th anniversary of the Council on Environmental Quality, which was placed in the President's own office to analyze and coordinate federal environmental policy and advise the President on environmental matters. Unlike a decade ago, we now have strong institutions like the Environmental Protection Agency and the National Oceanic and Atmospheric Administration to carry out environmental protection activities and to develop and implement sound policies. In addition, established government agencies like the Departments of the Interior and Agri-

culture and the U.S. Army Corps of Engineers have significantly redirected their missions. We are continually upgrading our environmental research and information activities to improve our current efforts and to meet future problems. In sum, the basic institutions for improving the quality of our environment are now firmly in place.

The past decade has been a remarkable beginning. I look forward to cooperating with the Congress and with all nations in our efforts to make this earth a better place to live. Let us move confidently into a second decade of environmental progress.

JIMMY CARTER

THE WHITE HOUSE

EXECUTIVE OFFICE OF THE PRESIDENT
COUNCIL ON ENVIRONMENTAL QUALITY
722 JACKSON PLACE, N. W.
WASHINGTON, D. C. 20006

LETTER OF TRANSMITTAL

THE PRESIDENT:

Sir: The Council on Environmental Quality herewith submits its tenth Annual Environmental Quality Report in accordance with Section 201 of the National Environmental Policy Act of 1969 (42 U.S.C. 4341).

Respectfully,

Gus Speth
Chairman

Jane Yarn
Member

Robert Harris
Member

HIGHLIGHTS

CHAPTER 1 AIR QUALITY

- [O]verall, the nation's air quality is improving. Combined data from 25 major metropolitan areas show that the number of unhealthful days declined by 15 percent between 1974 and 1977 while the number of very unhealthful days declined 32 percent. (p. 17)
- [D]ata from approximately 50 of the most polluted counties across the country show that violations of ambient air quality standards generally either stayed constant or decreased between 1974 and 1977. (p. 17)
- In 1977, the air in 2 of the 41 urban areas for which reliable data were available [New York and Los Angeles] still registered in the "unhealthful" range for more than two-thirds of the days of the year. . . . In 3 . . . air pollution appears to have gotten worse between 1974 and 1977. (p. 17)
- The pollutants that most frequently drove index readings into the "unhealthful" range in the 41 urban areas were carbon monoxide and photochemical oxidants (ozone). (p. 17)
- In January 1979, EPA announced its widely debated decision that the primary standard (designed to protect human health) [for ozone] would be relaxed from .08 parts per million to .12 parts per million. (p. 18)
- EPA [also] tighten[ed] limitations on emission of sulfur dioxide from new coal-burning power plants. (p. 18)
- Ozone levels appear not to have changed greatly from 1974 to 1977 in most of the counties monitored in the eastern and central United States. . . . However, counties examined in the western United States displayed a generally decreasing number of violations of ozone standards. . . . [T]he problems in the Los Angeles Basin . . . remain far more serious than elsewhere in the nation. (pp. 44–45)
- Carbon monoxide has shown marked improvement [between 1974 and 1977] in the counties monitored, with the greatest change evident in the East. (p. 45)
- Sulfur dioxide problems are not widespread in the United States; of 753 counties monitored in the nation for this pollutant, fewer than 50 showed any violations of the 24-hour primary ambient air quality standard in 1977. (p. 45)
- States must have State Implementation Plans (SIPs) that spell out in specific detail how federal [air pollution] goals will be met. Most SIPs are currently in the process of being revised [because] [t]he 1977 Clean Air Act amendments established deadlines later than those in the original 1970 legislation for attaining ambient air standards. (p. 61)
- The cut-off date by which states should have developed revised SIPs . . . was July 1, 1979. Although most states (44) submitted their plans by late

July, only one state, Wyoming, had an approved plan in place by the . . . deadline. . . . However, EPA expressed confidence that most plans would be approved by the fall. (p. 61)

- [C]urrent [pollution control] systems are often found to be malfunctioning because of poor auto maintenance or owner tampering. The Congress has therefore mandated that auto inspection and maintenance programs be instituted in all regions of the country where an extension of the ozone standard attainment date from 1982 to 1987 will be required. . . . Inspection and maintenance programs have become a highly controversial aspect of national air pollution control programs. . . . (p. 63)
- Acid rain is a major environmental problem on both sides of the Atlantic Ocean. . . . In the eastern half of the United States, the acidity of rainfall appears to have increased about 50-fold during the past 25 years. . . . Sweden placed the economic loss to its recreational and commercial fishing industry [due to acid rain] at $50 to $100 million in 1973. (pp. 70–71)

CHAPTER 2 WATER QUALITY

- Problems with water quality data collection and assessment are still numerous. But the available evidence, based on analysis of U.S. Geological Survey (USGS) data, suggests that water quality in the United States, while not showing vast improvement since the early 1970s, is at least not getting worse. . . . [T]here has been little or no overall change in the levels of five major water pollution indicators [fecal coliform bacteria, dissolved oxygen, total phosphorus, total mercury, and total lead] over the 4 water years, 1975 through 1978. (pp. 75–78)
- EPA reports that point sources affect water quality in 91 percent of the basins, and nonpoint sources affect it in 87 percent. (pp. 86–87)
- U.S. laws and social institutions are far better equipped to deal with point source controls than with nonpoint source controls. . . . As nonpoint sources increase in relative importance as the cause of water pollution, cleanup will become increasingly difficult, involving, for example, questions of technology, economics, management, and enforcement. (p. 88)
- CEQ made a close examination of trends in water pollution at 44 selected cities on major rivers. . . . Of 149 comparisons of violation rates, 69 showed improvement in water quality, 41 showed degradation, and 39 showed no change. (p. 88)
- As many as two-thirds of the nation's lakes may have serious pollution problems. . . . An estimated 80 percent of more than 3,700 urban lakes in the United States are significantly degraded. . . . (p. 89)
- DDT . . . was banned in 1972 in the United States, but fish from Lake Michigan still contained more than agree[d] [upon] maximum safe concentrations of DDT in their flesh as late as 1976. Similar slow declines in fish tissue concentrations have been noted for PCBs and other persistent organic materials in the Great Lakes. (p. 98)
- Controlling pollution from toxic substances in the Great Lakes Basin will be a special challenge. Much of the information on the manufacture and use of toxic chemicals is confidential, so that compilation of a complete list of all substances manufactured in the Great Lakes Basin is very difficult. The IJC [International Joint Commission] has made a start at compiling such a list, which now contains more than 2,800 different compounds. (p. 102)
- Among the major ground water quality problems in the United States is contamination from surface and subsurface waste disposal and storage—

including impoundment or burial of industrial wastes. . . . An EPA survey completed in June 1978 has identified more than 133,000 "ponds, pools, lagoons, and pits" used for treatment, storage, or disposal of wastes in the country. (p. 110)

- A special problem for many of the nation's older municipalities in meeting the goals set out in the 1972 water pollution legislation is that of combined sewer overflows. . . . [N]ationally 38 million people are served by approximately 1,300 combined collection systems. Combined sewer service areas are concentrated in the Northeast, in the upper Midwest, and in the far West. (pp. 114–115)
- EPA estimates it will cost $106.2 billion for construction and repair of municipal wastewater treatment facilities and sewers between 1978 and 2000. An additional $62 billion is needed for control of storm water runoff. (p. 118)
- Land treatment projects in two communities, Muskegon, Mich., and El Reno, Okla., show the reality and the promise of crop production as a method of treating wastewater. . . . Average grain yields in 1976, 1977, and 1978 [on cropland in Muskegan irrigated with wastewater] were about 80 bushels per acre, indeed remarkable considering that the sandy soil would otherwise produce only a few bushels of corn per acre. . . . The total crop income has averaged $900,000 during the past 3 years, which offset one-third of the costs of operations and debt retirement for the whole wastewater treatment system. (pp. 124–126)
- The Federal Water Pollution Control Act of 1972 required EPA to set technology-based effluent control limits for all industries discharging wastes into U.S. waters. Best Practicable Technology (BPT) controls were to be in place by July 1, 1977. . . . The latest survey [of compliance status] was conducted during April 1979, and revealed that, of the 795 [out of 3,977 major] nonmunicipal facilities that failed to achieve BPT standards by the [1977] deadline, action had been taken in 648 of the cases. (pp. 136–137)
- EPA regions II and IV conducted 242 sampling inspections of major industrial permittees. Of those, 82 (33 percent) disclosed at least one violation of NPDES permit conditions. (p. 138)
- [T]he greatest number of public water supply systems in our country are ground water systems, even though a minority of citizens use them. . . . In the next few years, the nation will have to address three basic and difficult problems concerning safety of drinking water: [c]arcinogens in source and finished water . . . [d]rinking water supply in water starved areas . . . [and] [a]ging distribution systems. (pp. 159–162)
- The world's oceans have come under increasing ecologic pressure from ocean disposal of ordinary and toxic municipal and industrial wastes. . . . [M]unicipal sewage sludge disposal has increased between 1973 and 1978, while industrial waste dumping has dropped by about 50 percent. Paradoxically, the rise in sewage sludge dumping is directly related to the national water cleanup effort. (p. 162)

CHAPTER 3 TOXIC SUBSTANCES AND ENVIRONMENTAL HEALTH

- [T]here may be 32,000 to 50,000 disposal sites in the United States containing hazardous wastes, and of these, anywhere from 1,200 to 2,000 may pose signicant risks to human health or the environment. Most of these dumps are still being used; perhaps 500 to 800 are abandoned. (p. 174)
- In August 1978, the N.Y. State Department of Health . . . [i]nvestigating residents' complaints of abnormal numbers of miscarriages, birth

defects, cancer, and a variety of other illnesses, found that hazardous chemical wastes had leaked from rotted drums buried in the old Love Canal into the basements of nearby homes and into the area's air, water, and soil. . . . Air monitoring equipment identied pollution levels as high as 5,000 times the minimum safe levels. (p. 176)

- In 1978, there was a rise in casualties from toxic transportation accidents, with 45 deaths and 1,411 injuries nationally. (p. 179)
- EPA estimates that only about 10 percent of hazardous wastes are being disposed of in a manner that would comply with regulations that the agency expects to adopt. The vast majority of toxic wastes (80 percent by weight) is being disposed of in nonsecure ponds, lagoons, or landfills. Another 10 percent is being incinerated in a manner that pollutes the air or does not completely detoxify the waste residues. (p. 182)
- EPA reported that [17 industries] . . . spend approximately $155 million per year for hazardous waste management. [P]roper management in accordance with proposed regulations would raise that figure to $750 million annually (or one-quarter of 1 percent of the value of production—$267 billion—of the 17 industries). [A] survey by the Manufacturing Chemists Association reported only 1 of 475 industry surface impoundments containing hazardous wastes would meet new disposal criteria. . . . Preliminary estimates by the association indicate an expenditure of nearly $900 million [would be required]. (p. 182)
- No public agency has enough money to clean up all the inactive dumps, costs that have been estimated at $28.4 billion to as much as $55 billion. . . . In June 1979, the Carter Administration proposed a $1.6 billion fund to cover the costs of cleaning up emergencies like Love Canal, and to respond to emergency hazardous substances and oil spills. The fund would be financed through fees levied on the oil and chemical industries together with a federal appropriation. (pp. 183–185)
- [E]ven after adjustments for age, the rate of cancer mortality—deaths due to cancer—has been increasing by 0.5 percent annually in the United States and the rate of incidence—new cases—by 1.6 percent. (p. 188)
- It is very difficult to atttribute with any degree of accuracy the observed incidence of cancer to specific factors—pollutants, manufactured chemicals, dietary components, or contaminants. However, a recent government estimate places the fraction of cancer that is related to occupational factors at 20 to 38 percent, for the present and the next several decades. . . . Previous estimates of the amount of cancer due to occupational exposure had been much lower. . . . (p. 196)
- [W]ith the constant discovery of new suspected carcinogens in various products . . . it may appear that about anything, if given in sufficient doses, will cause cancer. This is an entirely misleading idea. . . . The evidence so far indicates that substances either do or do not cause cancer. . . . As of 1977, it was estimated that about 1,500 [suspected carcinogens] had been investigated sufficiently to draw some conclusions. . . . [A]bout 600 to 800 had shown substantial, positive evidence of carcinogenicity. (p. 198)
- [S]cientists generally agree that properly qualified tests on mice, rats, hamsters, or other mammals yield meaningful results on carcinogenicity for humans. Indeed, crucial animal tests revealed the carcinogenicity of several substances that did prove to cause cancer among humans when they became widely used. (p. 199)
- [M]ore and more people began seeking compensation [in 1978 and 1979] from various government agencies for radiation damages they claimed to have suffered in the past. . . . [A]bout 600 residents of Nevada, Arizona, and Utah . . . have filed suit against the Department of Energy

(DOE). . . . [M]ore than 500 former military men have filed claims [with] the Veterans Administration (VA). The VA has turned down 92 percent of all bomb-related claims because it will only accept symptoms, diseases, or injuries that turn up during service or within one year of discharge. (pp. 206–209)

- On February 28, 1979, the EPA Administrator issued emergency orders suspending the registration of certain uses of two related herbicides—2,4,5-T and Silvex. . . . The action was based on human evidence and animal tests, both indicating that 2,4,5-T, Silvex, and their common contaminant . . . generally known as dioxin, have the potential for causing miscarriages, birth defects, and other adverse reproductive effects. (p. 210)
- The Toxic Substances Control Act, passed by the Congress in 1976 after 6 years of effort, represents one of the most far-reaching, comprehensive, and complex regulatory programs ever attempted by the federal government. . . . Most of this agenda still has to be carried out. . . . Two groups of chemical substances have been regulated to date under TSCA: polychlorinated biphenyls (PCBs) and certain chlorofluorocarbons (CFCs). (pp. 215–219)
- On March 13, 1978, OSHA published the permanent benzene standard . . . [but] the Fifth Circuit Court . . . stayed the standard from going into effect. The importance of this case is that it would require OSHA to quantify the exact benefits of regulation prior to the issuance of a health standard—that is, to quantify the human cancer risk associated with exposure to benzene at one part per million, despite the inherent difficulties of pinpointing cancer risks. . . . The opinion in this case is in conflict with rulings in three other Circuit Courts. . . . [T]he Supreme Court agreed to hear the argument. (pp. 224–225)
- On November 14, 1978, OSHA promulgated a lead standard of no more than 50 micrograms per cubic centimeter ($\mu g/cc$) of air in the workplace. The standard went into effect on March 1, 1979. However, both industry and the unions have challenged the standard, which is now partially stayed. (p. 225)
- Recent studies cost doubt on the primacy of lead-based paint as a cause of elevated blood lead levels [in children]. . . . [G]asoline lead appears to be an important source of lead in New York City children's blood. (pp. 227–228)

CHAPTER 4 MUNICIPAL SOLID WASTE

- Municipal waste, which rose at a rate of 5 percent a year from 1960 to 1970, slowed to a rate of about 2 percent a year from 1970 to 1978, but is still on the upswing. . . . Total U.S. municipal waste was estimated at 154 million tons for 1978, the equivalent of 1,400 pounds per person. (p. 256)
- [New EPA] criteria to be used in identifying "open dumps" . . . will be far-reaching in their effect. . . . Facilities that allow open burning or facilities sited in wetlands, floodplains, habitats of endangered species, or recharge zones for principal sources of local drinking water are generally defined as unacceptable under these regulations and will have to be phased out. (p. 264)
- Squeezed by increasing amounts of waste, disappearing disposal sites, and tightening restrictions on use of the sites, many local government officials and businesses involved in solid waste disposal have begun to consider alternatives to disposing of wastes in sanitary landfills. (p. 256)
- [T]he two basic alternatives for recycling solid waste [are] source separation, which is based on sorting of trash in the home or business and ap-

propriate reuse of its various components; and centralized resource recovery, which usually involves burning trash at a central facility for its energy value and may also include separation of some components for recycling. (p. 260)

- The United States converted less than 1 percent of its municipal wastes to energy in 1977. . . . [A]nother 7 percent of the nation's municipal solid waste was being recovered for its material value by recycling centers and other source separation programs. (p. 261)
- In 1978, 40 cities had some kind of [source separation and] collection program for the full gamut of recyclables, and another 196 collected newspapers. More than 3,000 independent voluntary community recycling centers were in operation . . . [and] more than 500 offices have paper recycling programs. (p. 265)
- EPA has estimated that a maximum feasible source separation effort nationwide could result in the recycling of about 25 percent, by weight, of total gross discards. (p. 266)
- The cost of collecting, sorting, and baling recyclables generally exceeds the revenues from their sales. Source separation is an economically viable proposition for most towns that have instituted it because it is a cheaper way of getting rid of wastes than operating a sanitary landfill or town incinerator. (pp. 270–271)
- [T]he percentage of paper products made from recycled fiber . . . [was] about 22 percent in 1977. . . . Less than 10 percent of all steel produced in this country is currently made from scrap steel that has gone through a cycle of use, and almost all represents industrial rather than consumer waste. . . . [o]nly 3 percent of glass production uses recycled raw materials. . . . For source separation to grow as a waste disposal method in the United States, long-term markets will have to be found for the systems' products. (pp. 272–275)
- [I]nterest [in centralized waste processing for energy recovery] has grown. . . . [T]he General Accounting Office was able to identify 20 trash-to-energy plants in operation and another 10 under construction at the end of 1977. Advanced planning had been completed for 30 more, and preliminary planning had begun on another 70 facilities. (p. 276)
- EPA estimate[d] [in 1973] . . . that the maximum possible energy yield from trash was about 900 trillion Btus . . . enough energy to meet the home and office lighting needs of the entire nation. (p. 277)
- Technological barriers are probably the least serious obstacle to wider [centralized] resource recovery at this time. Problems can be minimized by employing proven, relatively simple trash-to-energy systems now in use in both Europe and the United States. (p. 282)
- Trash-burning plants have certain very appealing environmental characteristics when compared with other energy facilities. They produce no radioactive wastes. Nor do they emit large quantities of sulfur dioxide. (p. 287)
- Nevertheless, trash-to-energy plants do emit measurable quantities of fine particulates, certain potentially hazardous organic compounds, viruses and bacteria, and toxic elements such as calmium, lead, and mercury. . . . Health hazards, such as harmful dusts and vapors, infectious disease or viruses, and excessive machine noise, may also occur inside the facilities. (p. 287)
- American political and business institutions are structurally ill-adapted to centralized resource recovery. . . . [U]tilities, which might logically be the best market for the energy produced and are prime candidates for owning and operating recovery facilities, appear loath to get involved. (pp. 288–289)

- Solely on the basis of the energy they produce, complex trash-to-energy facilities definitely are not yet economically competitive. . . . Resource recovery facilities are able to break even or turn a profit only because the revenue they receive from sale of steam or fuels is supplemented by the amount the municipality pays them for getting rid of the wastes, known as a "tipping fee". . . . (p. 290)
- Many people in fact now think that the best approach in developing a centralized recovery facility is to design the system to work in tandem with source separation at the outset. (p. 295)
- [T]he Resource Conservation Committee, a special interagency Cabinet-level group, gave special consideration [in its report issued June 1979] to a mandatory national system of deposits and refunds for beverage containers. . . . Staff studies . . . indicated such legislation would: Reduce litter volume by 35 percent; . . . Reduce the amount of solid waste by up to 2 million tons per year, or 0.5 to 1.5 percent; . . . Eliminate between 4,900 and 10,400 jobs in the glass container production industry and between 14,200 and 22,000 jobs in the metal can production industry over a 5-year period; . . . Create between 80,000 and 100,000 new jobs in the beverage distribution and retail sectors. (pp. 296–297)

CHAPTER 5 ENERGY

- In 1978 U.S. demand for energy increased slightly. . . . U.S. energy consumption in 1978 totaled 78.2 quadrillion British thermal units (QBtus), topping the consumption of 76.5 QBtus recorded in 1972. . . . (p. 321)
- An indication of increasing energy efficiency in industry is a continuing decline in the energy required per unit of national output. In 1978 the energy/gross national product (GNP) ratio declined 2 percent, to reach about 56,400 Btus per dollar of GNP (1972 dollars). By comparison, the ratio was about 61,200 Btus per dollar in 1972. (p. 323)
- Under law, the average fuel economy for each manufacturers' entire fleet of new cars for the year had to be 18 miles per gallon (mpg) by 1978, and 27.5 mpg by 1985. . . . Average new car sales-weighted fuel economy, as determined by EPA's Federal Test Procedure, has risen steadily from a low of 14.4 mpg in 1974 to 19.6 mpg in 1978. However, these improvements have not been fully realized in performance on the road. (p. 323–324)
- In November 1978 the President signed into law the National Energy Act, which culminated 18 months of intense congressional and public debate. . . . Several provisions of the National Energy Act of 1978 are expected to produce more efficient and productive use of energy and thereby reduce energy demand [including] . . . weatherization grants at an annual authorized level of $200 million; . . . [and] grants to states totaling $900 million to assist schools and hospitals, fund energy audits, and install energy conservation and solar measures. . . . [In] addition DOE is required to set energy efficiency standards for a wide range of appliances. . . . (pp. 318–326)
- [A] CEQ report, *The Good News About Energy* [issued in February, 1979, concluded that] . . . [w]ith a moderate effort to increase energy productivity, our year 2000 energy consumption need not exceed current use by more than about 25 percent. With a more determined effort, energy consumption need not increase by more than about 10 to 15 percent. At the same time, total real GNP could increase sharply to nearly double today's level. (p. 327)

- The Harvard study, *Energy Future,* reached conclusions similar to those of CEQ. . . . The Harvard report found that over the longer run the United States can use 30 to 40 percent less energy than it now does with "virtually no penalty for the way Americans live." (p. 329)
- Under existing federal law, price controls on oil will expire on September 30, 1981. . . . [T]he President decided in April 1979 to soften the economic shock of a sudden lifting of price controls, by phasing out controls at a fairly uniform rate over a 28-month period beginning in June 1979 and ending in September 1981. . . . At the same time, the President asked Congress to enact a windfall profits tax on oil producers. (p. 330)
- Price controls [on natural gas] will be lifted by category of use. . . . The price of new natural gas will be decontrolled on January 1, 1985. (p. 331)
- In an effort to increase OCS [Outer Continental Shelf] oil and gas production, the President's Energy Message of April 1979 directed the Secretary of the Interior to propose additional acreage to the existing leasing schedule. . . . Some of the lease sales planned for the next few years are in forbidding environments where offshore experience is scanty and the risks are great. An example is the Arctic waters of Alaska's Beaufort Sea. . . . Exploration and development of such areas will require a high degree of sophisticated environmental planning. (pp. 333–334)
- [U]nderground coal mining continues to be one of the nation's most hazardous occupations. . . . [P]reliminary figures identify 105 fatal and 13,554 nonfatal injuries in coal mining in 1978. From 1930 to 1978 the frequency of injuries and fatalities declined substantially. (pp. 338–339)
- The Department of the Interior has developed a comprehensive new coal leasing program [announced] [o]n June 4, 1979. . . . (p. 341)
- [T]o help provide new sources of fuel for transportation and to reduce U.S. dependence on imported oil from insecure sources, the President proposed [in his July 15, 1979 energy message] a large-scale effort to help private industry develop and to produce synthetic fuels from biomass and our abundant domestic coal and oil shale resources. (p. 346)
- The possible environmental risks of converting coal and shale to oil or gas are significant. [T]he possible hazards from toxic trace metals and organic carcinogens—both in the conversion process and in the oil and gas products—are troubling. . . . (p. 347)
- The effects of synfuel development on land and water must also be carefully considered. Assuming that the mix of domestic energy in 1990 includes about 1.25 million barrels per day of synthetic fuels derived from coal, about 25 plants would be needed . . . in the West, about 500 square miles of land would be strip mined over the 30-year lifetime of the plants. . . . If the energy mix also included 400,000 barrels per day of synfuels from shale, about 100 to 200 [additional] square miles would be required. (p. 355)
- The total water consumption of the synfuel industry outlined would be enough to irrigate roughly 100,000 acres of agricultural land per year. This much water may be physically available . . . in the West, but it may already be committed to . . . other purposes. . . . [N]ew towns to house plantworkers will put further pressure on water supplies. (p. 351)
- Woldwide use of all fossil fuels, including coal-based synthetic fuels, may have to be curbed if present concerns about the impact of carbon dioxide are confirmed. The primary concern with increased carbon dioxide emissions centers around the so-called "greenhouse" effect—the trapping of outgoing infrared radiation from the earth's surface. (p. 351)

- On June 20, 1979, President Carter delivered to the Congress the nation's first Presidential message on solar energy. . . . The President called for a combined effort by the federal government, state and local governments, industry, and private citizens, to achieve a national goal of meeting 20 percent of our energy needs with solar and renewable resources by the end of the century. (p. 358)
- Over the past 2 years, the federal financial commitment to developing and commercializing renewable energy technologies has been significantly increased. Federal expenditures, which were at a level of $358 million in fiscal year 1978, will rise to over $1 billion in fiscal year 1980. (p. 360).
- As of March 31, 1979, 70 nuclear power plants with a combined generating capacity of 51,000 megawatts electrical (Mwe) were licensed to operate in the United States on 48 sites in 37 of the 48 contiguous states. Together they supply about 13 percent of the nation's electrical power and about 4 percent of total U.S. energy. (p. 361)
- The most serious accident in the history of U.S. nuclear power began in the early morning hours of March 28, 1979 [caused by a] chain of what was thought to be highly improbable events. . . . [Prior to the accident], the Nuclear Regulatory Commission had already taken a second look at the Reactor Safety Study (The Rasmussen Report), . . . widely quoted as concluding that the risk to the general population from light water reactor nuclear power plants was negligible. . . . The NRC announced that it was withdrawing any explicit or implicit past endorsements of the executive summary of the report . . . . (pp. 361–364)
- In May 1979, President Carter reaffirmed his opposition to the construction of the Clinch River Breeder Reactor (CRBR) project. . . . He committed the Administration to a study of alternative reactor designs, calling for more modern, economic, and safe breeder reactor components and fuel cycles. (p. 364)
- The Interagency Review Group on Nuclear Waste Management (IRG) made its final report to the President in March 1979. The report concluded that . . . "Existing and future nuclear waste from military and civilian activities . . . should be isolated from the biosphere. . . ." (p. 365)

CHAPTER 6 NATURAL RESOURCES

- *The Second National Water Assessment* of the U.S. Water Resources Council (WRC) [released December, 1978] found shortages of surface water in several regions of the country, as well as overdrafts of ground water—resulting in declining water tables—in parts of the High Plains, Arizona, and California. The WRC report concluded that there is a special need for better conservation and management, particularly in irrigated areas of the West. (p. 375)
- Water shortages are particularly acute in the lower Colorado River Basin. . . . [I]n central Arizona and southern Nevada, ground water levels are declining an average of 8 to 10 feet per year. (p. 379–380)
- In some areas, declining water tables will cause abandonment of water-depleting activities before the water is totally consumed because of the increasing cost of the energy required to bring it to the surface. This has already begun in the Trans-Pecos areas of Texas. . . . Abandonment of large irrigated areas began recently when prices for natural gas used to run the pumps made continued production uneconomical. (pp. 380–381)
- [I]ntensive irrigation-based farming is increasing the soil salinity on several hundred thousand acres [in California's San Joaquin Valley.] According to a recent federal-state study, some farmers have been forced

to switch to salt-tolerant crops, and annual crop losses from sali
now exceed $30 million per year. (p. 383)

- [O]n October 5, 1978, the House of Representatives sustained the
dent's veto of the fiscal year 1979 public works appropriation bi
[T]he bill included funding for more than two dozen water projec
did not meet minimum Administration economic or environmental
ards and would ultimately have cost $1.8 billion dollars to constru
388)

- Despite an investment by the federal government of more than $20
in support of soil conservation practices since 1935, erosion of agric
lands remains one of the nation's most serious problems. . . . Th
National Resource Inventory Estimates show a national average lo
water-induced erosion in excess of 4 billion tons. (p. 389)

- The nationwide loss of plant nutrients due to erosion is significa
USDA estimates the annnual cost of replacing all of the nitrog
phosphorus and one-fourth of the potassium lost by soil erosion at .
billion in 1979 dollars. (p. 393)

- [A]lthough 48 of the 50 states [have] adopted farmland preservatio
ures, most states [have] dealt with the issue primarily through pr
allowing preferential property tax assessment. . . . [O]ther types of
vation programs [include] . . . purchase of development right
cultural districting, and transfer of development rights. (p. 391)

- In response to growing expressions of concern about the availab
agricultural lands, Agriculture Secretary Bergland and CEQ Ch
Warren initiated [in 1979] an 18-month federal study of the availa
agricultural lands—particularly prime farmlands—and their conve
other uses. (p. 402)

- Debate continued through 1979 over the disposition of Alask
wilderness. . . . [o]n December 1, 1978, President Carter issued an
series of proclamations invoking the Antiquities Act of 1906, w
aside 56 million acres as 17 national monuments [in Alaska]. (p. 40

- The largest and most controversial wilderness issue of 1978 and 1
the Forest Service's Roadless Area Review and Evaluation Process
II). . . . In the RARE II Final Environmental Impact Statement
January 4, 1979, the Department of Agriculture recommended
million acres of National Forest land be designated as wilderness
President concurred with the recommendations. . . . (pp. 405–40

- The Bureau of Land Management, as required by the Federal Lan
and Management Act, has begun a separate wilderness invent
evaluation process on 174 million acres of its lands. (p. 406)

- The "Omnibus Parks" Act of 1978 added eight new river segm
total of approximately 696 miles) to the National Wild and Sceni
System. . . .The System now protects a total of more than 2,317 mi
rivers. (p. 407)

- The "Omnibus Parks" Act also established the first new nation
since two initial national scenic trails were created . . . the Con
Divide Trail, spanning a distance of 3,100 miles along the Rocky
tains from the Canadian to the Mexican borders, and [four]
Historic Trails. (p. 411)

- An increasingly important national problem in the future may
cutting of privately held forest land, particularly land held by la
panies. A study released in January 1979 by the Library of Cong
cluded that the Forest Service, farm, and other small rural lan
appear to be cutting their softwood timber at a rate closer to a l

sustained yield level than timber companies. . . . In 1977, the timber industry's . . . cut exceeded growth by 21 percent. (p. 420)

- [S]erious conflicts continue to exist between ORV users and desert homesteaders, hikers, scientists, and environmentalists. . . . (pp. 421–422)
- President Carter, in December 1977, authorized a review of nonfuel minerals marketing and regulatory policies . . . The draft report [released in August 1979 indicated]: Federal government planning and decisionmaking involving nonfuel minerals is uncoordinated . . . The data gathering and analysis capability required to support nonfuel mineral policymaking in the federal government is deficient or nonexistent. Efforts to control environmental pollution problems associated with the mining and processing of nonfuel minerals have been successful in limiting some pollutants. Other problems are not adequately regulated. (pp. 426–428)

CHAPTER 7 ECOLOGY AND LIVING RESOURCES: COASTAL ECOLOGY AND SHELLFISH

- Coastal waters . . . are the nexus of several major natural systems. They directly abut the land and are affected by activities there—not only on coastal lands in the immediate vicinity, but also on land great distances away. . . . Human activities have a profound impact on this complex system in ways that are sometimes difficult to unravel and often unexpected. (p. 434)
- Urban and suburban watersheds release more suspended and dissolved substances, including nutrients, into streams than do natural watersheds. . . . In addition, in an urbanized watershed, peak flows after a heavy rain are very high and pass quickly. (pp. 436–439)
- Molluscs can be used as indicators of environmental quality both by measuring the amount of pollutants accumulated in shellfish tissue and by keeping track of harvest statistics. (pp. 443–444)
- [I]nformation provided by two [EPA] studies . . . indicates that [molluscs] still contained DDT residues 4 years after the use of the chemical was banned in 1972. . . . The situation for [PCBs], the manufacture and some uses of which have now been banned, is more alarming. . . . , Even molluscs in otherwise relatively clean waters show as much as 50 ppb. For higher values—even above 600 ppb—have been observed in molluscs from . . . Boston Harbor, Narragansett Bay, R.I., and Rockaway on the south shore of Long Island. . . . (pp. 445–448)
- Mussels have also shown the presence of radionuclides, for the most part apparently a legacy of the weapons testing program of the 1950s and early 1960s. However, one sample from Plymouth, Mass., suggests that the mussels are concentrating effluents from a nearby nuclear reactor. (p. 448)
- Records of commercial catches of clams and oysters . . . indicate that the number of molluscs in coastal waters has been steadily declining during the years. . . . When government records and landings statistics were initiated in 1879, an annual harvest of 117 million pounds of oysters was being taken from Chesapeake Bay alone. This figure is more than five times what the bay now provides, and is more than double the present total U.S. consumption of oysters. (pp. 450–453)
- [Causes of declines include] [o]verfishing, habitat loss and deterioration, pollution, economic developments, natural disasters, and political and sociological considerations. . . . The Department of the Interior's National Estuary Study of 1970 shows an annual loss of estauarine habitat . . . that translates to 0.21 percent annually from 1950 to 1969. A study for the U.S. House of Representatives published in 1970, indicates an annual loss of 0.36 percent between 1947 and 1967. (pp. 455–456)

- Even the building of a sewage treatment plant has the potential to adversely affect shellfish habitat by altering salinity. Trouble arose for the shellfish of Great South Bay when attempts were made to solve Long Island's sewage disposal and water quality problems. (p. 457)
- [I]ntensified agriculture, urbanization, construction, and lumbering, have greatly accelerated rates of sedimentation . . . [D]uring a 36-year period, 6,000 to 7,000 acres of productive oyster reefs were smothered in Matagorda Bay, Tex. (p. 461)
- There is general agreement that pollution has been a major cause of the decline of molluscan shellfish within recent decades. It is the principal problem confronting the commercial hard clam fishery, and a major one for the soft clam and oyster fisheries. (pp. 461–462.)
- The most recent National Shellfish Register shows 4 million of the 14.6 million acres of commercial shellfish waters to be closed . . .Prohibited polluted areas (closed to shellfishing) have increased from 16.1 percent of all commercial and noncommercial shellfish waters in 1971 to 18.5 percent in 1974 . . . (pp. 466–467)
- Several laws provide mechanisms for protecting the coastal zone, especially its fisheries. The National Marine Fisheries Service (NMFS) compiled and categorized a list of such laws. . . .[It] concludes that these laws, if carefully implemented during a period of years, are adequate to protect the resource and should result in a healthy coastal environment. However, . . . complete implementation of these laws has so far not taken place, resulting in the continued deterioration of the resource, albeit at a lessened pace. (pp. 470–471)

CHAPTER 8 HUMAN SETTLEMENTS AND LAND USE

- In the 1970s two demographic trends have become particularly striking in all parts of the country: the trends toward small households and population dispersal in rural areas. (p. 477)
- In the 1960s, when population grew at 1.3 percent per year, new households were formed at the rate of 1.8 percent per year. But since 1970, with population increasing at 0.8 percent per year, households are being formed at the rate of 2.6 percent per year. Between 1970 and 1977, average household size dropped 10 percent, from 3.14 persons to 2.86 persons (p. 478)
- [B]etween 1970 and 1978, nearly 350 nonmetropolitan counties, containing about 8.5 million people, grew at a rate three times (16.7 percent) that of the nation—rates that are typically associated with developing nations, although there the growth is from high birth rates, not migration. (p. 480)
- The migration to rural areas represents a reversal of the previous decline in rural population, but not a return to a rural society. A continuation of the 1970 to 1975 rates to the end of the century would still result in a nonmetropolitan population proportionately less than that of 1950. (p. 480)
- A large number of federal laws affect private land use decisions directly or indirectly. . . . The large majority of these laws have objectives other than the promotion of wise land use *pre se*. (p. 485)
- Efforts during the past year to site three new energy facilities in coastal areas reveal many of the inadequacies of the current planning process for such plants, as well as the difficulty of evaluating numerous and varying environmental effects. . . . [The proposed facilities were] two major oil refineries on the East Coast—at Eastport, Maine, and Portsmouth, Va.—

and a large liquified natural gas (LNG) storage facility at Point Concepción, Calif. . . .(pp. 485–490)

- [T]o help federal decisionmakers and industrial site planners identify the coastal areas least suitable for major energy and industrial facilities and those whose protection is most essential, NOAA, FWS, CEQ, and other federal agencies began in mid-1979 to develop new coastal maps of critical areas, beginning with the east coast. (p. 495)
- The siting and constructing of major inland energy extraction and production facilities is fostering rapid growth in certain rural areas. (p. 495)
- Federal assistance to small inland communities to deal with energy-facility-induced growth—i.e., to expand housing, health, education, social services, transportation, and other services—has been neither coordinated nor targeted. (p. 498)
- The vulnerability of coastal resources and the intensity of the land use conflicts there provided an impetus for creating a federal/state land management partnership under the Coastal Zone Management Act of 1972 (CZMA). . . . Between 1974 and September 1979, $70 million was distributed to states to help them develop coastal management programs. . . . To date, 15 [of 35 eligible] states have received federal approval for their coastal management plans. (p. 500)
- The CZMA has encouraged states to improve the coordination and simplification of governmental regulatory procedures. . . . The federal consistency provisions under CZMA allow states to review federal agency activities (except those on federal lands), to insure that they conform to federally approved state coastal management plans. (p. 508)
- The accomplishments to date under the CZMA are significant, but weaknesses in this innovative land use management approach do exist, including variations in state programs and the fact that some states have no programs at all. (p. 510)
- The Chesapeake Bay illustrates many of these shortcomings all too clearly. . . . Toxics, such as the Kepone that still persists in the James River; municipal sewage, estimated at 400 million gallons per day; and oil from nearly 800 petroleum spills per year, have closed shellfish areas, reduced fish catches, and destroyed valuable wildlife. . . . [Yet because of state inaction,] the bay has no comprehensive, integrated multistate coastal management. . . . (p. 510–512)
- Tax approaches are becoming increasingly important in protecting historic buildings. . . . From March 1977 through June 1979, more than 900 historic preservation rehabilitation *projects* in 42 states had been certified by HCRS [Heritage Conservation and Recreation Service] as eligible to use tax incentives under the 1976 [Tax Reform] Act. . . . (p. 515)
- In many cities, young middle-class professionals are renovating buildings in rundown city neighborhoods . . . for residential use. . . . The impact of such change can be negative as well as positive. . . . A study of 30 cities found that 48 percent of the neighborhoods were predominantly black before new middle-income residents moved in, while only 2 percent remained so afterwards. Other studies have shown a similar displacement of renters, blue-collar workers, the unemployed, and the elderly. (p. 519)
- The National Commission on Neighborhoods, in its March 1979 report to the President, urged public and private actions to maintain neighborhood diversity and assist current residents.
- In line with current national policies of fostering energy conservation, reliance on public transportation, and improved air quality, President Carter announced in April 1979 that subsidized parking for federal employees would be phased out. (p. 523)

- During fiscal year 1980, Amtrak trains will run 34 percent fewer train-miles than the current system would have in that year. However, the recommended system will retain approximately 80 percent of the passenger-miles included in the current system and will serve 91 percent of the passengers who would have used the system. (p. 526)

CHAPTER 9 NOISE

- [N]oise is the most frequently mentioned undesirable neighborhood condition in central cities. . . . (p. 534)
- Perhaps the most serious consequence of noise exposure is its effect on hearing. . . . It is estimated that as many as 20 to 25 million people—about 1 in 10 in the United States—are exposed to noises of duration and intensity sufficient to cause a permanent reduction in their ability to hear. Of these, 10 to 15 million are estimated to be workers exposed to excessive noise on the job. (p. 534)
- The idea that people become totally accustomed to noise is a myth. Although we may get used to constant low-level noise, the human body will make automatic and unconscious responses when exposed to sudden or loud sounds. . . . Growing evidence strongly suggests a link between noise and cardiovascular problems, especially hypertension. (p. 537)
- Reading ability also may be seriously impaired by noise. A study of reading scores of 54 children in grades two through five indicated that the influence of noise in the home was a more significant factor affecting reading performance than the grades the youngsters were in, the parents' educational background, or the number of children in the family. (p. 538)
- An estimated 40 percent of the U.S. population is exposed to L_{dn} of 55 or more, versus 22 percent in Norway, 50 to 70 percent in most of Europe, and 80 percent in Japan. But aircraft noise is relatively worse in the United States: 13 percent of the population is exposed to L_{dn} levels greater than 55, whereas only 3 percent is exposed to those levels in Japan and Europe. (p. 545–546)
- In 1977, there were more than 6,000 [hearing loss] claims at the state level, resulting in awards of approximately $13 million. At the federal level there were approximately 2,300 claims amounting to awards of $17.6 million. . . . The cumulative state and federal benefits paid from 1977 to 1987 could easily reach $0.8 billion. (p. 546–547)
- [A]n estimated 13.5 million people in the United States are exposed to an outdoor L_{eq} of 75 dB or greater from transportation or recreation vehicles, a level sufficient to cause risk of permanent damage to hearing. Even after federal noise regulations take effect, overall noise from cars, trucks, buses, and motorcycles will increase over time because of the anticipated increase in the number of vehicles. (p. 547)
- If current regulations controlling noise emissions from aircraft are implemented, and if special takeoff procedures are used, the land area exposed to aircraft noise L_{eq} levels of 65 or greater will decrease from 2,169 to 1,304 square miles by 1985. The number of adversely affected people is expected to decrease from about 6 million to about 3.6 million by the year 2000, although it then may grow again with increasing air traffic. (p. 547)
- In early 1979, 164 local communities and 10 states had performance or in-use [noise] requirements for automobiles. These programs range from enforcement of existing local, state, or federal regulations to stringent local laws that require periodic inspection of vehicles. (p. 549)
- In the past decade the number of local noise control ordinances has increased dramatically. In 1972 only 59 municipalities had some type of

noise law. . . . Today, more than 50 percent of the U.S. municipal population lives in localities having some degree of noise legislation. (p. 554)

- State [and local noise control] programs are [often] underfunded, which generally means that ordinances or other regulations cannot be implemented. In 1977, 27 states had enacted noise legislation, but only 20 states had budgets to support legislation. Only 11 states were spending more than $0.01 per capita per year on noise control programs. (p. 555)
- The Noise Control Act of 1972 specifies that EPA shall regulate new products that are "major sources of noise". . . . Since 1972, EPA has identified 10 products as major noise sources: medium and heavy trucks, motorcycles, buses, garbage trucks, wheel and crawler tractors (used in construction), portable air compressors, pavement breakers (or jack hammers), rock drills, power lawnmowers, and truck refrigeration units. (p. 559)
- OSHA proposed a revised [workplace noise] standard in 1974 that would keep [the former standard of] 90 dB for 8 hours, but would tighten other parts of the existing regulation. This proposed revised standard has not yet been adopted. . . . Under authority of the 1972 Act, EPA recommended that OSHA adopt a more stringent standard of 85 dB for 8-hour exposures. . . . (p. 562)
- Hearing protectors have sometimes been advocated as an all-purpose alternative to engineering controls of noise, but they are an inferior alternative. [H]earing protectors are by far the least expensive method for reducing noise exposure, but . . . workers resist wearing them, either because they need to hear the sounds around them for reasons of safety or communication, or because the devices are uncomfortable. In addition, their effectiveness in practice is limited. (p. 562)

CHAPTER 10 NEPA

- The Council's [new] NEPA regulations . . . were promulgated in final form in November 1978. The new regulations . . . are binding on all federal agencies. . . . They are designed to produce more useful, readable, tightly focused documents and to reduce delays through a variety of changes. (p. 577)
- One of the most significant innovations in the new NEPA regulations is the "scoping" process. When a federal agency determines that a proposed action requires preparation of an EIS, it must take prompt action, at the very beginning of the planning process, to identify the important issues that require full analysis and to separate those issues from the less significant matters. (p. 578)
- Another important innovation is the requirement that when an EIS has been prepared, the agency must produce a written record of its decision on the proposal. . . . [T]he record . . . must state whether all practicable means for mitigating environmental harm have been adopted and, if not, why not. (p. 578)
- Impact statements must be analytic rather than encyclopedic and must be written in plain language. The regulations state that EISs should normally have fewer than 150 pages . . . (p. 579)
- The regulations also address a long-standing controversy—the possibility of conflicts of interest when applicants for federal permit or funding approval participate in the environmental analysis of the project. The regulations require that the EIS be prepared by the federal agency or by a contractor selected by the agency. . . . (p. 579)

- An important feature of the regulations is improved integration of NEPA procedures with other environmental review laws and federal permit requirements. (p. 579)
- One of the most difficult problems in NEPA implementation during the years has been integrating the EIS process with the legislative process. The new regulations streamline the procedures for legislative EISs by allowing a single legislative EIS (instead of a draft and final) to be submitted to Congress under certain circumstances. (p. 581)
- After 7 years of divided opinion in government, the Carter Administration approached the issue [of whether and how NEPA applies to federal actions abroad] in a way sensitive both to environmental and foreign policy concerns. . . . Executive Order 12114 signed on January 4, 1979 . . . [requires that] federal agencies prepare environmental impact statements for major federal actions that have significant environmental effects on the global commons (e.g., oceans and Antarctica). Second, under certain circumstances agencies must prepare concise environmental reviews. . . . (p. 582)
- The Supreme Court's opinion in *Andrus* v. *Sierra Club* lends strong judicial support to the new NEPA regulations and CEQ's continuing efforts to reform the EIS process. The Court quoted extensively from the regulations on such diverse subjects as the purpose of environmental impact statements, the timing of EIS preparation, the definition of an EIS, and the definition of "major federal action." (p. 584)
- Th[e] decision [of the First Circuit in *Public Service Co. of New Hampshire* v. *NRC*] continues and strengthens a series of NEPA cases holding that substantive requirements in NEPA's Section 101 and 102(1) give agencies authority to minimize adverse environmental damage, even when the agency's statutory charter does not authorize affirmative measures to protect the environment. (p. 585)
- During 1978, there were 114 lawsuits challenging federal actions under NEPA. This continues the levelling-off trend in NEPA litigation observed over the past 3 years. The most frequent complaint in 1978 NEPA lawsuits, comprising 57 percent of all allegations, is that agencies should have prepared an EIS but failed to do so. The second most common allegation is that an EIS is inadequate. (p. 588)
- During the 9-year period [January 1970 through December 1978] . . . lawsuits were filed [regarding] . . . less than 10 percent of all federal proposals for which an EIS was prepared. (p. 590)
- A review of these 1,052 NEPA lawsuits reveals that 103 cases involved specific energy projects. . . .[o]f the[se] . . . 103, only 17 resulted in temporary or preliminary injunctions related to NEPA issues. . . . NEPA litigation and preliminary injunctions have not presented a significant obstacle to the development of energy projects. (p. 590)
- Federal environmental laws other than NEPA have been the subject of increasing litigation. . . . Roughly two-thirds of the approximately 750 lawsuits pending against EPA at the end of 1978 have been industry challenges to regulations. By comparison, citizen lawsuits and mandatory court enforcement actions represent less than 15 percent of lawsuits against EPA. (p. 591)

CHAPTER 11 THE GLOBAL ENVIRONMENT

- Throughout the tropical world, forests are disappearing at alarming rates. . . . A United Nation's estimate, based on observation in 13 countries, puts the net loss at 11 million hectares (27 million acres) per year—an area roughly the size of Virginia. Estimates from U.S. government agencies

. . . indicate the losses may be closer to 20 million hectares (50 million acres) per year. If the latter estimate is correct, the world's closed forests . . . would decline from one-fifth of the earth's land surface to one-sixth of the land surface by the year 2000. (p. 607–609)

- Virtually all this loss [of forests] is taking place in or near the tropics. Environmental damage from deforestation in these areas can be extreme . . . [I]ntensified ruinous flooding, which has followed denudation of mountain slopes in many countries throughout history, is occurring increasingly today in tropical watersheds. (p. 609)
- The soils and other conditions of tropical forests are quite unlike those of the temperate zone. In many places, the soil is so seriously degraded after deforestation that the original forest will not grow again, and the land cannot support crops or pasture for more than a few years. (p. 610)
- Tropical forests are enormously diverse. . . . [But] species may be of very limited geographic distribution, and because they have no means of wide dispersal, once they are gone, there is no recolonization from outside. (p. 610)
- The importance of this loss [of species] becomes obvious when one considers . . . that one-quarter of the prescription drugs dispensed in the United States today are either derived directly from wild plants or are invented using chemical clues derived from wild species. . . . as many as half come from tropical forests; [of these,] . . . The genetic resources of wild plants are also valuable for breeding new characteristics, such as disease or pest resistance, into food plants. They may even supply new [food plant] species. . . . (p. 610–611)
- The principal direct causes of tropical forest loss are clearing for agriculture, fuelwood gathering, and industrial timbering. But behind these immediate causes are more fundamental social and economic problems—lack of agricultural development, great inequalities in land tenure and income, rapidly growing populations, and rising unemployment. (p. 612)
- Industrial forestry is increasing rapidly, especially in Southeast Asia. (p. 613)
- [T]he World Bank has altered its policy for forestry loans. The Bank announced in 1978 that instead of supporting only industrial forestry projects, it would also support environmentally protective forestry, rural development forestry (for example, establishment of village woodlots for fuelwood), and institution-building projects that emphasize education and research in forestry and agroforestry. (p. 615)
- Rapid deforestation in the tributary watersheds of the Panama Canal Zone is one of the complex of causes leading to lowered water levels in the canal system. If current trends continue, by the year 2000 the Republic of Panama might take over from the United States a "worthless ditch." Panama and the United States are aware of the danger and are planning cooperative action to restore and stabilize the capacity of the canal. (p. 615)
- At its July 1979 meeting, the International Whaling Commission . . . voted to: Halt whaling from factory ships on the high seas (except for hunting of the relatively numerous minkes) . . . Reduce killing of the commercially valuable but jeopardized sperm whales by more than three-quarters; . . . Establish a whale sanctuary in most of the Indian Ocean. (p. 616)
- The possibility of global climate change induced by an increase of carbon dioxide in the atmosphere is the subject of intense discussion and controversy among scientists. . . . [M]any scientists believe that the amount of CO_2 in the atmosphere could double over the hundred years ending in the

middle of the next century. . . . [T]he result could be a 2° to 3° Celsius rise in temperature in the middle latitudes, with larger increases in the upper, lower, and polar regions. (pp. 621–622)

- These [CO_2-induced] changes could conceivably affect the exent and stability of Greenland and Antarctic ice with consequent rising sea levels and inundation of low-lying coastal areas and changes in the productivity of ocean fisheries. Precipitation and growing seasons for crops could be greatly altered, possibly disrupting world agriculture. (p. 622)
- With increasing competing demands for land available for disposal of low-level radioactive waste, several more nations are looking toward the oceans as an alternative to land burial. . . . The countries most active in disposal of radioactive wastes at sea have been Belgium, the Netherlands, Switzerland, and the United Kingdom, with the greatest share of the radioactive waste coming from the United Kingdom. (p. 623)
- The worst oil spill in history began June 3, 1979, with the blowout of IXTOC No. 1, a well being drilled in the Bay of Campeche by PEMEX, Mexico's national oil company. Estimates of the oil spilled ranged from 10,000 to 30,000 barrels per day. . . . (p. 624)
- Convening in Paris in May 1979, the OECD environment ministers reported improved environmental protection over the past decade, at affordable cost. . . . They note that the short-term net employment effects have been positive; the impact on inflation has been on the whole moderate, averaging 0.1 to 0.3 percent per annum; and the effect on the rate of economic growth in the short run has been neutral, perhaps even slightly positive. Overall, expenditures by OECD countries on pollution abatement amounted to 1 to 2 percent of GNP. (pp. 626–628)
- A fundamental factor shaping the quality of the environment for humankind is the spectacular growth in human population in this century. In 1930, the world's population stood at 2 billion, but by 1975—only 45 years later—it had doubled to 4 billion. . . . According to the estimates, world population may stabilize at 8 to 11 billion early in the 21st century. (p. 633)

CHAPTER 12 ECONOMICS

- [I]t sometimes appears that regulation, or any other government action for that matter, is judged with reference to one narrow national economic goal—lower prices. (p. 644)
- Although environmental regulations can contribute to inflation, they—or any other programs—must be judged on broader grounds. (p. 642)
- Private costs of production are those the producer actually bears—labor charges, the cost of capital, rent, utilities, and so on. Social costs include . . . certain other costs that some producers in the past have been able to escape paying—for example, the medical costs incurred by those subjected to the air pollution from a nearby plant. . . . [E]nvironmental legislation was drafted in response to this divergence between private and social costs. It was based on the clear recognition that existing market prices were giving incorrect signals to consumers by understating what society was giving up to have [these] goods. . . . (pp. 642–643)
- [A]lthough no one likes paying more for the same product, the higher prices that may result from regulation may improve the overall allocation of the nation's resources. (p. 643)
- Environmental regulation can [also] be viewed as adding to the size of the standard market basket. That is, regulation allows consumers to enjoy not only the same clothes, foodstuffs, housing, and so on as before, but also more environmental amenities. (p. 644)

- [T]he criticism that environmental regulation slows down the rate of growth of GNP must be viewed with care. As in the case of inflation, environmental regulation may do just what it is accused of doing, but to the nation's overall benefit and with its complete, though tacit, agreement. (p. 645)
- [A] report to CEQ [of existing studies] found major divergencies among estimates of air and water pollution control benefits. . . . For example, even after expressing estimates in 1978 dollars and standardizing for a 20 percent improvement in air quality, the study found that estimates of the health benefits of controlling air pollution from stationary sources still ranged from $1.8 billion to $14.4 billion. (p. 654)
- Because the ranges identified in the report to CEQ were so large, the study went further and selected a "most reasonable point estimate" (the single, most likely value) for both aid and water pollution control benefits. . . . According to the study, the annual benefits realized in 1978 from measured improvements in air quality since 1970 could be reasonably valued at $21.4 billion. Of this total, $17 billion represented reductions in mortality and morbidity, $2.0 billion reduced soiling and cleaning costs, $0.7 billion increased agricultural output, $0.9 billion prevention of corrosion and other materials damage, and $0.8 billion increases in property values. (p. 655)
- [T]he total annual benefits to be enjoyed by 1985 as a result of the nation's water pollution control legislation [are estimated at] about $12.3 billion per year, with recreation benefits accounting for $6.7 billion. . . . (p. 655)
- Between 1970 and 1978, federal environmental legislation added, on the average, slightly more than three-tenths of one percentage point to the annual rate of increase of the CPI [Consumer Price Index]. . . . [W]ith much of the required pollution control equipment now in place, the future contribution of existing environmental regulations to inflation will shrink. . . . between 1979 and 1986, federal environmental regulations will add between one- and two-tenths of one percentage point to the annual inflation rate. (p. 657)
- [A]ir and water pollution controls will serve to stimulate employment during the entire 16-year period [1970–1986]. By creating jobs in the pollution control equipment industry and jobs for those who operate and maintain this equipment, environmental protection reduces the unemployment rate by an average of one-fourth of one percentage point per year. (p. 658–657)
- Federal air and water pollution programs have a mixed effect on real GNP. . . . [B]etween 1970 and 1977, real GNP was higher because of the stimulus provided by pollution control programs than it would have been in their absence. In 1972, the difference was $14.4 billion, or 0.9 of 1 percent of real GNP. However, after 1977, air and water pollution control expenditures began to exert some drag on the economy. . . . (p. 659)
- [CEQ] estimates indicate that the cost of complying with all existing federal pollution control and environmental quality programs in 1978 was $26.9 billion. . . .Over the 10-year period from 1978 to 1987, total incremental spending in response to all federal environmental programs is projected at $477.6 billion. (p. 665–668)
- [T]he resources devoted to pollution control are not inconsiderable. Thus, it is reasonable to ask whether the nation's environmental goals might be met in a less expensive manner. . . . Effluent charges and marketable permits are the two forms of economic incentives that have received the most attention when alternative kinds of environmental policy are considered. In principle, both save money, but in practice it may not always be possible to reap all the savings these methods appear to offer. (pp. 668–671)

- Using data [from] . . . the Chicago Air Quality Control Region, [a 1979] study examined the cost and effectiveness of a variety of strategies that could be used to meet a *hypothetical,* short-term standard for nitrogen dioxide of 250 micrograms per cubic meter ($\mu g/m^3$). . . . The study concluded that both effluent charges and marketable permits would, if appropriately designed, meet and maintain the hypothetical ambient standard at lower cost than would a regulatory approach (p. 674)

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ENVIRONMENTAL QUALITY—1979

PROLOGUE

AN ENVIRONMENTAL DECADE

In retrospect, 1970 was the year the environment became a household word and a potent political force. It began with the signing, on the first day of the year, of the National Environmental Policy Act (NEPA). This law made it national policy to "encourage productive and enjoyable harmony between man and his environment," and it created the environmental impact statement review process and the Council on Environmental Quality.

In April, the first Earth Day brought a national outpouring of feeling against bad air and polluted water, degraded cities and scarred countryside—a broad-based, deep-seated expression of concern that not enough attention was being paid to preserving the earth and its resources, on which the well being of the nation's people depends. A Gallup poll soon after Earth Day confirmed the widespread nature of this concern; 53 percent of the public chose "reducing pollution of air and water" as the second most important problem facing government, barely behind "reducing the amount of crime." Just 5 years earlier, the pollution problem had placed ninth, behind "improving highway safety" and slightly ahead of "beautifying America."

In 1970, Congress began to enact a body of legislation which by the end of the decade would have a major impact on people's lives and the nation's way of doing business, possibly comparable with such earlier political changes as the New Deal in the 1930s, or the civil rights reforms of the 1950s and 1960s. In 1970 alone Congress passed amendments to the Clean Air Act, requiring establishment of national ambient air quality standards; the Occupational Safety and Health Act, mandating federal air pollutant and physical hazard standards for workplaces; and the Resource Recovery Act, calling for demonstration programs in waste recycling and better hazardous waste management. In that same year the President, by Executive order, reactivated a long dormant portion of the 1899 Rivers and Harbors Act and established the nation's first federal permit system for control of water pollution. The President created the Environmental Protection Agency out of several existing federal offices to oversee and manage pollution control programs.

What accounts for the burst of environmental consciousness at the beginning of this decade? What was behind the new ethic and out-

look that eventually brought such momentous changes in the nation's laws and priorities? Environmentalism was not, of course, a wholly new phenomenon. It had roots extending back into the last century, when sportsmen and nature lovers organized against the wanton destruction of America's wildlife; when Yellowstone, in 1872, became the world's first national park; when in 1891, 40 million acres were set aside in the first national forest reserve for protection against the rapacious timbering of the time. By the turn of the century, President Theodore Roosevelt and his chief of forest reserves, the great conservationist Gifford Pinchot, had expanded the national forests to 190 million acres, their approximate extent today. And throughout this century, particularly in the 1960s, the nation's concern for preservation of a magnificent natural heritage was expressed in a growing number of key conservation measures—such as the Wilderness Act of 1964, the Land and Water Conservation Act of 1965, and the Wild and Scenic Rivers Act of 1968.

Pollution was also a longstanding concern. Some cities began treating their sewage in the last century, and the first federal water pollution control law was passed in 1948. State and local governments had also made early efforts to combat air pollution. Cincinnati and Chicago passed smoke control ordinances in 1881, and by 1912, 23 of the 28 American cities with populations over 200,000 had passed similar laws. California's efforts to control smog began in the 1940s, with regulation of refineries and other industrial plants; automobile emission controls were added in the 1960s. The first federal air pollution law was passed in 1955.

What was different about the legislative initiatives of the 1970's was first, that they came in concert, and second, that, by and large, they had teeth. Somehow, the nation had collectively decided that it was time to act in a comprehensive and forceful way to preserve the quality of the environment. Even with hindsight, it is not obvious what caused this sudden and widespread public adoption of a new environmental ethic. Surely the causes were complex, including intellectual and scientific currents of the time as well as economic and social forces. Sorting them all out in a coherent fashion is a task that should pique the interest of historians for a long time to come. Some insights may be gained, however, from looking at certain major changes the nation underwent in the quarter century after World War II, and aspirations and values that won adherence in the years just before 1970.

Looking Back

The end of World War II marked the beginning of a period of remarkable prosperity, despite occasional recessions. Between 1950 and 1970, real income (personal disposable income per capita, adjusted for inflation) rose 52 percent. Average hours worked per week dropped by 7 percent. After one decade when the majority of

Americans had a hard time just getting by, and another decade of wartime strains, there was at last an easing of financial pressures and shortages. Many people—plumbers, policemen, shopkeepers, factory and office workers, as well as doctors, lawyers, and businessmen—finally could spend money on things they wanted, not just what they needed, and had more time to enjoy themselves.

People did several things in response to the new prosperity. First, they had babies. The U.S. population, which had grown by only 29 million people from 1930 to 1950, rose by 53 million in the following two decades.

Next, people looked for a nicer place to live outside the city. Since the mid-1800s, manufacturing jobs, rather than homesteads for farming, had gradually become the key to financial betterment. The waves of immigrants reaching our shores had remained primarily where the factories were—in the cities. At the same time, a stream of people left the farms for the cities. Farm population declined more or less steadily, from about 29 million (30 percent of the nation's population) in 1900 to 23 million (15 percent of total population) in 1950.

As affluence increased in the 1950s, vast numbers of people who for generations had come to live in urban centers decided to allocate a large portion of their newly acquired disposable income to improving the quality of their physical environment. Of all the options

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ESTATES
VACATION LAND • HOME • CITY SEWERS • WATER • INTERCOM MUSIC SYSTEM
COUNTRY CLUB FACILITIES • BUILT-IN APPLIANCES • BEAUTIFUL LIGHTING
SWIMMING POOL • HEATING • COOLING • LARGE CLOSETS
WADING POOL • CONTROLLED LIGHT • TUB-SHOWER ENCLOSURES
TENNIS COURTS • CERAMIC TILE BATHS • COLORED BATH FIXTURES
BOATING • FISHING • HARDWOOD FLOORS • ERMINE HOODS-FANS
PICNIC ISLAND • VINYL FLOORS • KITCHEN • TELEPHONE JACKS • CHIMES
AIR COND. • INSULATED • CORK FLOORS • OVEN • VENETIAN BLINDS
LARGE LOTS • LANDSCAPE • METAL HOOD CABINETS • DISHWASHERS

In 1957, a 400-acre dairy farm 12 miles outside Newport News, Va., becomes a housing development. Photographer: Lester Fox.

available to them, people by and large chose to invest their extra funds in a house in the suburbs. Between 1950 and 1960, as the population grew by 19 percent, the number of people in the suburbs rose by 45 percent. By contrast, the inner city population grew by 12 percent and nonmetropolitan areas by only 6 percent. In the 1960s, the suburban growth rate was 28 percent, or about twice that of the general population. Rural and inner city areas both grew by just 7 percent. In 1950, suburbanites were still a minority in the nation: the total inner city/suburban/rural population distribution in the United States in 1950 was 54/41/57 million. By 1970, suburbanites had a plurality, with the distribution standing at 63/74/63 million.

Much was subsequently written about the negative effect the mass migration to the suburbs had on the nation's environment, including loss of farmlands and woodlands and the economic life-blood of the urban core. Yet it must be remembered that the decision of each family to move to the suburbs—though clearly influenced by such factors as schools, neighbors, and crime rates and definitely assisted by government policies such as low-cost mortgages—was at least in part an environmental choice. Many families decided to spend a substantial portion of their new-found affluence to exchange urban living, often cramped and noisy, sometimes dark and dirty, for grass, trees, a piece of sky, and some space.

Further evidence that Americans were eager to use their newly acquired prosperity and leisure to experience a natural environment can be found in the statistics on national park use. Park visits doubled between 1954 and 1962 and doubled again between 1962 and 1971. By 1971, the parks were registering approximately 200 million visits a year, or an average of about one per citizen. It seems that, given a little extra disposable income and leisure time, one of the first things Americans chose to do was to get outdoors.

Unfortunately, the substantial shift of population to the suburbs—and the economic expansion, and technological change that made it possible—began to have some side effects that few people had bargained for. The expansion of the suburbs themselves began to affect the environment in a phenomenon known as sprawl. People who lived on the fringes of cities saw cherished lands disappear: potato fields on Long Island, orange groves outside Los Angeles, pheasant and deer-filled woods outside Boston. Many of the earlier urban emigrees saw the country which they had come to enjoy vanish before their eyes. Those who came later found it harder and harder to locate a house within a reasonable commuting distance of the city, especially if they wanted a little "country" around it. Automobile congestion increased. New highways were built to alleviate traffic jams, but it seemed that no sooner were they built than they were filled to capacity, and they brought noise and fumes and a loss of rural character.

This is not to suggest that the majority of Americans now living in the suburbs became disillusioned and rejected that life. No doubt, for the most part, they still thought they had made a good bargain. It does appear, however, that the decision to pick up and move to a

A Sunday afternoon traffic jam on the Blue Ridge Parkway, October 1968.

less crowded space, which Americans had been making since they settled this nation, had become more complicated. For metropolitan areas that had "just growed," without direction, plan, or thought for the consequences, some disturbing costs had begun to be apparent.

At the same time, certain by-products of the nation's phenomenal economic growth also began to be noticeable. Between 1950 and 1970, while population grew by 37 percent (for every 300 people at the start of the period, there were more than 400 by the end of it) the Gross National Product approximately doubled. The manufacturing component of the GNP also doubled; wholesale and retail trade doubled; transportation, communications, and utilities almost tripled; and construction almost doubled. Expenditures for gasoline and oil quadrupled.

The impacts of these activities were increasingly evident. Long vistas and clear skies were obscured by murky air; and smarting eyes, coughs, even hospital admissions, and sometimes higher death rates accompanied air pollution episodes. Polluted coastal waters were closed to shellfishing, and streams where the weekend fisherman had formerly found plenty of salmon and bass became devoid of life. Stretches of unspoiled river and ocean shoreline became harder to find.

By-products of prosperity in the 1950s and 1960s were increasing air and water pollution from industrial plants like this steel plant near Pittsburgh. Photographer: John Alexandrounez.

The chemical industry in particular experienced phenomenal growth, with production rising fivefold between 1950 and 1970. There were significant qualitative changes as well. After World War II, for the first time, there was widespread production and use of synthetic organic materials—substances invented by man that do not exist in nature. Scientists had learned to design molecules to order, and began using this skill to convert petroleum and other basic raw materials into substances that could be woven into clothes, wrap foods, kill insects and weeds, and serve hundreds of other uses.

As these substances gained acceptance, it became increasingly obvious that they could create unexpected problems. Plastic wrappers and bottles thrown from a car window or washed up on a beach

seemed to lie there forever. In fact, natural decomposition processes cannot break down some of these synthetic substances; they are immune to rust and rot. The effects of some of the new compounds on living things began to appear dangerously unpredictable. There were reports of farm workers suffering pesticide poisoning, and of fish kills and declines in game birds in forests where pesticides had been sprayed.

By end of the 1960s, many of those who had sought to better their lives and to enjoy in their leisure time some of the nation's environmental endowments found the quality of their environment subtly eroding. But for most people it was not yet apparent what the trouble was exactly, much less whether anything could be done about it.

One event that focused public concern and helped people understand some of the changes taking place was the publication in 1962

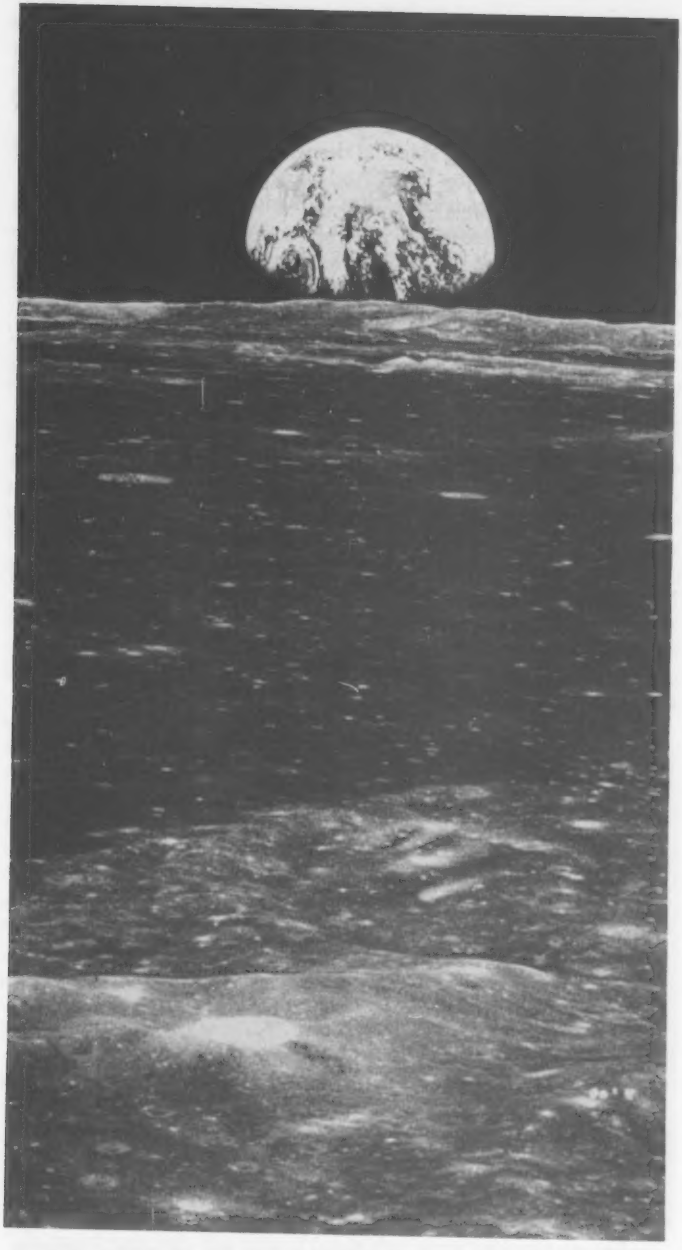
Toxophene sprayed on clover field in 1957. Photographer: John McConnell.

of *Silent Spring*. Rachel Carson's book showed many people that pollution is more than an aesthetic problem—causing a bad smell or obscuring a beautiful view—it is a threat to the complex processes of life itself. The book made the connection between the widespread use of DDT and other persistent complex pesticides and the failure of many birds to hatch their young. It discussed how exposure to certain chemicals could cause cancer, and how certain insects were developing strains that were resistant to pesticides. The title of the book alone spoke volumes to many Americans.

Other events also struck responsive chords. In 1966, for example, the Sierra Club took on its first major grassroots-based national political fight and ran a series of ads opposing a federal Bureau of Reclamation plan to construct a dam in the lower Colorado River to provide electricity for Los Angeles. Headlined "SHOULD WE ALSO FLOOD THE SISTENE CHAPEL SO THE TOURISTS CAN GET NEARER THE CEILING?" the ads argued that the sacrifice of irreplaceable lands to technology had to stop somewhere, certainly at the Grand Canyon. Enough people shared the Sierra Club's view that the organization's membership doubled within 2 years.

Yet the environmental movement might not have coalesced just when it did had it not been for other significant trends and changes. Since the 1940s, radical improvements in transportation and communication had been bringing the far corners of the world much closer together. Air travel had become commonplace. Millions of Americans had the experience of being on the east coast in the morning and the west coast in the evening. Television entered nearly every home, and everyone could see what had happened worldwide on the same day it happened. Most of the interstate highway system was completed, making it possible to drive from coast to coast in less than a week, and from suburb to city in minutes. Then, in 1969, man left the earth and walked on the moon, making the earth look finite indeed. All of a sudden the world shrank. Whereas in earlier times, it might have been difficult to work up much concern over pollution from a factory hundreds of miles away, improved communication made the problem immediate. One of the basic axioms of environmental thinking—that "everything is connnected to everything else"—became, in a very few years, plausible and understandable to many more people.

The environmental changes of the 1970s also probably owed a great deal to the social upheavals of the 1960s, and the generation of questioning, socially concerned, and politically aware young people those times produced. The 1960s began with civil rights demonstrations and ended with the bitter conflict over the Vietnam War. Especially for young people, whom the war affected most closely and personally, it was a period of profound questioning of the country's major institutions—government, academic, and business—in terms of their actual effects on the people they were supposed to serve. It was also a period of experimentation with new values and modes



Earthrise, from the surface of the moon, July 1969.

of living, from the sexual revolution to the "back-to-the-land" movement, and of reaction against what many saw as the materialistic bent of their parents' generation.

The environmental outlook, with its opposition to careless impersonal use of technology in a way that destroys life rather than conserving it, had strong spiritual ties with the peace movement and the ethical climate of the 1960s. And many young people came out of the 1960s with the conviction that individuals have the power and responsibility to take control of their own lives, and to make changes in society. Thus, it is not surprising that quite a few young people were early and ardent participants in the environmental movement, organizing public demonstrations and lobbying Congress as a means of pursuing their goals.

In this context, it is not so strange that one event, an oil spill in the Santa Barbara Channel in 1969, should have so galvanized public opinion and catalyzed a strong political response. In retrospect, Santa Barbara was neither the worst nor the most frightening environmental disaster the nation has experienced. It fouled many miles of an exceptionally beautiful beach and killed seabirds by the thousands. But unlike the Donora, Penn., air pollution episode, no one was killed; unlike the Love Canal tragedy, no one suffered permanent health damage; unlike the nuclear accident at Three Mile Island, no large numbers of people were threatened. Indeed, because of the circumstances of the spill, the ecological damage at Santa Barbara proved to be less severe than in several smaller, less publicized oil spills. Yet the event dramatized what many people saw as thoughtless insensitivity and a lack of concern on the part of

Oil-soaked birds, like this eider duck stranded on Cape Cod, are common casualties of oil spills. Photographer: Wallace Bailey.

government and business to an issue that had become deeply important to them. It brought home to a great many Americans a feeling that protection of their environment would not simply happen, but required their active support and involvement.

Reversing the Tide

By 1970, it was generally apparent that if the nation was going to improve the quality of its environment, a new legal framework was needed. There were of course other dimensions to environmental progress in the 1970s: six Presidential Messages on the Environment, the most recent President Carter's Message of August 2, 1979; commitment and hard work by the Executive Branch; action by individuals and thousands of local and national groups; sophisticated, sympathetic judgments by the courts. But the laws were by and large the bedrock.

Building on the laws enacted in 1970, Congress rapidly added more legislation of great significance. The Federal Water Pollution Control Act, passed in 1972, had as its ultimate goal the restoration and maintenance of the "chemical, physical, and biological integrity of the Nation's waters." It called for establishment of federal guidelines for employment of pollution control technology and set a target date of 1983 for achieving fishable, swimmable waters.

Protection of water resources was extended to oceans by the Marine Protection, Research, and Sanctuaries Act of 1972 (commonly known as the Ocean Dumping Act) and to ground water and surface drinking water supplies by the Safe Drinking Water Act of 1974.

Toxic substances received more and more attention as the dimensions of the problem became clearer. The Federal Insecticide, Fungicide, and Rodenticide Act, originally passed in 1948, was significantly strengthened in 1972. Then, with passage of the Toxic Substances Control Act and the Resource Conservation and Recovery Act in 1976, standards and procedures could be established for control of toxic substances at all stages of their life cycle, from creation to disposal. The need for such standards has become ever more apparent, as the legacy of earlier use and disposal practices has unfolded—from the Hudson River with its massive contamination by PCBs; to Love Canal, where a stew of discarded chemical wastes endangered the health of hundreds of families; to Hopewell, Va., where Kepone was the cause of serious damage to human health and the James River and Chesapeake Bay fisheries.

The environmental outlook of the 1970s also began to permeate laws and programs that had other principal purposes. The environmental emphasis on conservation and development of renewable energy resources, for example, powerfully influenced the energy legislation of the middle 1970s. President Carter's energy program is founded on conservation, and sets a goal for the year 2000 of 20 percent of U.S. energy supply from solar sources.

In transportation, the federal funds that were formerly poured exclusively into highway construction are now available for building

public transportation systems in cities. Local governments seeking federal assistance are no longer locked into programs that create sprawl, but may choose other options that can make the urban environment more livable. To promote these changes, President Carter declared a new transportation policy in his 1979 Environmental Message, and proposed as part of his energy program investing $16.5 billion in improving public transportation and automobile fuel economy.

The Noise Control Act of 1972 and Quiet Communities Act of 1978 made further contributions to improving the quality of urban life.

Looking back on the literature of the period, it appears that most of the recommendations for new legislation outlined in reports and studies (including CEQ's First Annual Report published in 1970) were met. A major exception was land use. A comprehensive land use planning act was considered and debated by Congress in the early 1970s, but never passed, in part due to concern that it would interfere too much with state prerogatives and individual land use rights.

Some of the goals of the proposed land use law, however, have been incorporated into other laws. The Federal Water Pollution Control Act of 1972 directed the Army Corps of Engineers to review and restrict dredge and fill activities in wetlands on the basis of their environmental impact. The Coastal Zone Management Act, passed in 1972, provided funding for state land use planning in coastal areas. The Endangered Species Act of 1973 requires the protection of the "critical habitat" of an endangered species in any project with federal involvement. The Surface Mine Reclamation Act of 1977 set standards to control disturbance of the land from coal mining, and to assure reclamation afterward.

Significant progress has also been made toward better land use practices on the one-third of the nation's lands in the public domain. Under the Forest and Rangeland Renewable Resources Planning Act of 1974, the Forest Service must assess the nation's public and private renewable resources and make long-term plans for protection and development of resources on the 187 million acres of Forest Service lands. Then, the National Forest Management Act of 1976 set out in specific terms how the Forest Service should carry out a multiple-use/sustained-yield policy. In 1976, Congress also passed the BLM Organic Act which, for the first time, gave the Department of the Interior's Bureau of Land Management a clear mandate to manage for multiple use and sustained yield. BLM is responsible for managing about 450 million acres, or 60 percent of all federally owned lands.

In 1979, the Carter Administration recommended that 15 million acres of Forest Service land be given permanent Wilderness System designation, doubling the acreage in the system. And in 1979 the House voted to transfer 126 million acres of federally owned lands in Alaska (roughly one-third of the state) to one of the four special federal protection systems (National Parks, National Forests, Fish and Wildlife Refuges, and Wild and Scenic Rivers). In 1978, when

Wilderness in the proposed Gates of the Arctic National Park. Photographer: M. Woodbridge Williams.

Congress failed to act on the Alaska lands bill, the President had moved to protect 56 million acres by giving them National Monument status.

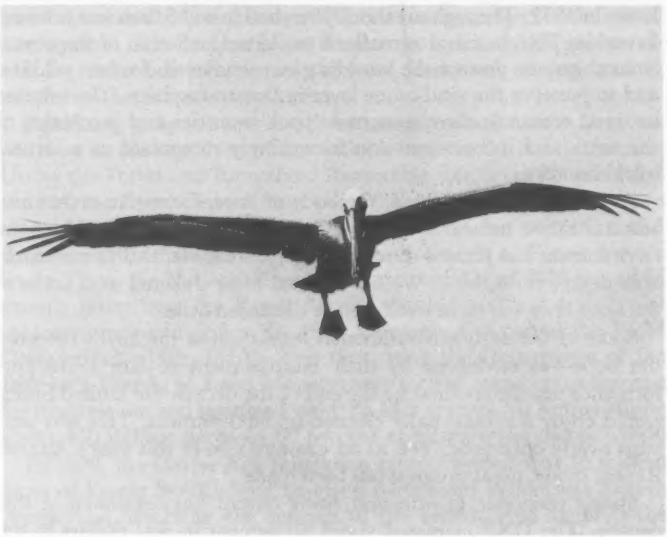
The ferment of environmental action in the 1970s was not confined to the United States. This nation took an active part in the United Nations Conference on the Human Environment in Stockholm in 1972. Throughout the 1970s, the United States was a leader in seeking international agreement to control pollution of the oceans from ships; to protect the world's great whales and other wildlife; and to preserve the vital ozone layer in the stratosphere. The relation between economic development in poor countries and protection of the earth and its resources was increasingly recognized as a critical world concern.

At the end of the decade, the body of laws, Executive orders and administrative measures developed during the 1970s to protect the environment has proved durable, largely workable, and to a remarkable degree far-sighted. We have added to or tinkered with some of the basic laws, but have weakened or discarded little.

Some of the early environmental legislation of the 1970s reflected the hope—as evidenced by their establishment of late 1970s performance deadlines—that by the end of the decade the United States would enjoy a substantially cleaned-up environment. This was perhaps overly optimistic. Yet, as an examination of this year's Annual Report shows, great progress has been made.

Strong economic growth and rising output has continued in this decade. The GNP increased about 30 percent in real dollars in the 1970s—about $300 billion, roughly the same figure as the GNP growth of the previous decade. Yet increases in the gross amount of "conventional" air and water pollution appear to have been halted.

Healthy Osprey nestlings are now hatching successfully several years after DDT was banned for most uses. Photographer: William Krontz.



The Brown Pelican was close to extinction from the effects of DDT, but is now making a comeback. Photographer: Jack Dermid.

Levels of DDT, the first toxic substance to be banned for most uses in the United States, have declined in fish tissues; and several birds—including the osprey, the brown pelican, and the bald eagle—which seemed headed for extinction because of DDT have begun gradually to increase in number. Dozens of other examples, many reported in the pages that follow, give further evidence of heartening progress.

With Knowledge and Forethought

Looking back on the decade, it is clear that the nation has faced itself in a new direction. That is not to say that no choking exhaust will ever again leave a tailpipe, that no worker will ever again breathe in a cancer-causing chemical, that no endangered plant or animal will ever be in jeopardy, that no pristine or unique wilderness area will ever be despoiled or that global resources, even the planet's atmosphere, will be proof against degradation from the actions of billions of humans. There is an immense amount to be done on these and many other environmental issues. And as the needs and goals of the nation change over the coming decades, no doubt new environmental problems and issues will arise and have to be faced.

What has changed in an important way is the nation's method of going about its business. Embedded not just in the law, but in the nation's consciousness, is now the belief that no new project should be undertaken without first seriously considering its effects on the ecosystem of which we are all a part. Though people may disagree vehemently over how to act on such knowledge, there are few who feel that major actions should be taken without considering this question.

It is fitting that this environmental decade began with the signing of NEPA. In some ways, NEPA may turn out to be the most influential of our environmental laws, for it not only sets forth our basic national goals for environmental protection, it also tells us that essential to achieving them is forethought. The Act requires that all federal government agencies, before undertaking major actions that could significantly affect the environment, make the effort to anticipate the consequences of those actions, and to avoid or mitigate harmful effects.

Rachel Carson in 1962 prefaced *Silent Spring* with the following statement by Albert Schweitzer: "Man has lost the capacity to foresee and to forestall. He will end by destroying the earth." In the early 1960s, for people thinking and writing about environmental problems, there was considerable agreement with this pessimistic view. But since then, much has in fact changed. The commitment to environmental progress has been made, and seems to be here to stay. While there is still much to learn, understand, and work out before the nation achieves and maintains a healthful, livable environment that can sustain people for centuries, we have embarked upon that journey.

CHAPTER 1

AIR QUALITY

A variety of indicators of air quality all point to the same conclusion: overall, the nation's air quality is improving. Combined data from 25 major metropolitan areas show that the number of unhealthful days declined by 15 percent between 1974 and 1977 while the number of very unhealthful days declined 32 percent. Nine of the more populous and more polluted areas in this group showed even greater improvement, with a 35 percent reduction in the number of unhealthful days since 1974. These improvements are mainly attributable to a reduction in automobile pollution.

Likewise, data from approximately 50 of the most polluted counties across the country show that violations of ambient air quality standards generally either stayed constant or decreased between 1974 and 1977. The greatest improvements were made in reducing violations of the carbon monoxide and sulfur dioxide standards. Violations of the primary ambient air quality standard (established to protect human health) for these pollutants declined by 43 percent and 54 percent, respectively, during the 4-year period. Photochemical oxidant (ozone) violations also decreased, by 24 percent. Carbon monoxide comes mainly from automobiles; sulfur dioxide from electric power plants and other industrial sources. Ozone arises from hydrocarbon and nitrogen oxide emission from both vehicular and industrial sources. The improvements occurred because of better control of all these sources and despite increasing population, more cars and trucks on the road, and more industrial activity.

Air pollution has by no means been eliminated, however. In 1977, the air in 2 of the 41 urban areas for which reliable data were available still registered in the "unhealthful" range for more than two-thirds of the days of the year. These two, the New York and Los Angeles urban areas, together contain almost 8 percent of the nation's population. Only 16 of the 41 urban areas had "unhealthful" readings for fewer than 10 percent of days during the year. In 3 cities, air pollution appears to have gotten worse between 1974 and 1977. The pollutants that most frequently drove index readings into the "unhealthful" range in the 41 urban areas were carbon monoxide and photochemical oxidants (ozone).

As directed by the Clean Air Act amendments of 1977,[1] the Environmental Protection Agency (EPA) is currently reviewing the

ambient air-quality standards for the five basic "criteria" pollutants, the first such review since the standards were issued in 1971. The first standards scrutinized were those for ozone. In January 1979, EPA announced its widely debated decision that the primary standard (designed to protect human health) would be relaxed from .08 parts per million to .12 parts per million. The reviews of the standards for the other four criteria pollutants—nitrogen dioxide (NO_2), carbon monoxide (CO), sulfur dioxide (SO_2), and total suspended particulates (TSP)—are scheduled for late 1979 and 1980.

An equally controversial decision was EPA's tightening of the limitations on emission of sulfur dioxide from new coal-burning power plants. Former emission limits could be met simply by burning low sulfur coal. By 1983, however, new power plants must avail themselves of existing pollution-control technology and must achieve 70 to 90 percent control of sulfur dioxide emissions depending on the coal's sulfur content.

As more and more cars equipped with emission-control devices come into use, air pollution levels in many cities should decline. However, poor maintenance, use of leaded in place of unleaded fuel, and owner tampering with these systems are causing them to be somewhat less effective than expected, and are adding to the difficulties some areas are having in meeting clean air standards. Various strategies proposed to reduce total auto use in high-pollution areas, from parking taxes to raising tolls on access routes, have met with strong opposition. In fact, the 1977 Clean Air Act amendments prohibited EPA from mandating some of these strategies.[2] At present, EPA is concentrating on requiring adequate state motor-vehicle inspection and maintenance programs in hopes that ambient air-quality standards for automotive pollutants can be achieved by 1987, the final deadline set by the 1977 Clean Air Act amendments.[3] In the long run, certain alternative types of engines and fuels that are being considered primarily as solutions to gasoline shortages could provide alternative means of achieving air quality goals.

CONDITIONS AND TRENDS

PRESENT URBAN AIR QUALITY

The Clean Air Act amendments of 1977 required all Air Quality Control Regions to standardize their monitoring efforts and report air quality levels using a uniform air quality index by August 1978.[4] In response, EPA adopted the Pollutant Standard Index (PSI), a health-related index designed to be reported by the news media so that susceptible persons can know and respond appropriately to changes in pollution levels. It also makes it possible to analyze and compare pollution levels on a uniform basis throughout the nation.

All state and local agencies that monitor urban areas of greater than half a million people have adopted PSI. Many that deal with urban areas of 200,000 to 500,000 people have also adopted PSI,

and universal use is now expected by the end of 1983.[5] The PSI is based generally on the primary short-term National Ambient Air-Quality Standards (NAAQS), and federal criteria for categorizing more severe pollution episodes (see Table 1–1). A PSI value greater than 100 means that the air quality is categorized as "unhealthful," greater than 200 as "very unhealthful," and greater than 300 as "hazardous."

The Council on Environmental Quality (CEQ) has analyzed PSI data by Standard Metropolitan Statistical Area (SMSA), units that reflect pollution levels throughout an urban area as opposed to levels within the central city alone. This analysis of the number of days per year that 41 SMSAs experienced various PSI levels suggests that many cities still have significant air pollution problems, particularly involving ozone and carbon monoxide. The SMSAs examined, those for which adequate data were available,* are 41 of the 60 most populous metropolitan regions in the United States.** The results of the analysis are shown in Figure 1–1. The figures beside each diagram show how many days during 1977 the air quality was unhealthful or worse and which pollutant was responsible. The 41 SMSAs are grouped according to the pollutant primarily responsible for the high daily index values.

Of the 41 SMSAs studied, five—New York, Chicago, Denver, Los Angeles, and San Bernadino-Riverside-Ontario—had index values in the "unhealthful" range (greater than 100) or worse, for 30 percent of the year. New York, Los Angeles, and San Bernadino-Riverside-Ontario had values in the "very unhealthful" range (greater than 200) or worse, for more than 20 percent of the year. For the first three SMSAs, carbon monoxide was generally the pollutant responsible for driving the PSI readings into the "unhealthful" range. For the latter two urban areas, however, ozone was most often the problem pollutant. In fact, for most of the urban areas, "unhealthful" days were caused primarily by either ozone or carbon monoxide.***

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*"Adequate" data means that a majority of the health-related pollutants were being monitored at one site or more, and there is a minimum of 300 daily observations per year for carbon monoxide and ozone. SMSAs with SO_2 and NO_2 problems also met the 300-day coverage requirement; those cities with high daily levels of TSP were assumed to monitor with sufficient frequency to describe such problems.

**The following 18 SMSAs could not be analyzed because of insufficient 1977 data in EPA's National Aerometric Data Bank: Boston, Pittsburgh, Phoenix, Newark, Minneapolis, Atlanta, Honolulu, Miami, New Orleans, Columbus, Paterson-Clifton-Passaic, Albany-Schenectady-Troy, Providence-Pawtucket-Warwick, Greensboro-Winston-Salem-High Point, Allentown-Bethlehem-Easton, Fort Lauderdale, Omaha, and Birmingham. Cleveland was omitted from the analysis because CEQ considered its 1977 CO monitoring unrepresentative.

***The present data show equal predominance for photochemical oxidants (primarily ozone) and carbon monoxide. In CEQ's Ninth Annual Report, oxidants were shown as predominant, but the change in the oxidant (ozone) standard from 0.08 to 0.12 parts per million is incorporated in this year's PSI calculations and is the reason for the different results.

Table 1–1

Definition of Pollutant Standard Index (PSI) Values

PSI Index Value	Air Quality Level	Pollutant Level					Health Effect	General Health Effects	Cautionary Statements
		TSP (24-hour), $\mu g/m^3$	SO_2 (24-hour), $\mu g/m^3$	CO (8-hour), mg/m^3	O_3 (1-hour), $\mu g/m^3$	NO_3 (1-hour), $\mu g/m^3$			
500	Significant Harm	1000	2620	57.5	1200	3750			
400	Emergency	875	2100	46.0	1000	3000		Premature death of ill and elderly. Healthy people will experience adverse symptoms that affect their normal activity.	All persons should remain indoors, keeping windows and doors closed. All persons should minimize physical exertion and avoid traffic.
300	Warning	625	1600	34.0	800	2260	Hazardous	Premature onset of certain diseases in addition to significant aggravation of symptoms and decreased exercise tolerance in healthy persons.	Elderly and persons with existing diseases should stay indoors and avoid physical exertion. General population should avoid outdoor activity.

200	Alert	375	800	17.0	400[c]	1130	Very Unhealthful	Significant aggravation of symptoms and decreased exercise tolerance in persons with heart or lung disease, with widespread symptoms in the healthy population.	Elderly and persons with existing heart or lung disease should stay indoors and reduce physical activity.
100	NAAQS	260	365	10.0	240		Unhealthful [a]	Mild aggravation of symptoms in susceptible persons, with irritation symptoms in the healthy population.	Persons with existing heart or respiratory ailments should reduce physical exertion and outdoor activity.
50	50% of NAAQS	75[b]	80[b]	5.0	120		Moderate [a]		
0		0	0	0	0		Good [a]		

[a] No Index values reported at concentration levels below those specified by "Alert Level" criteria.
[b] Annual primary NAAQS.
[c] 400 $\mu g/m^3$ was used instead of the O_3 Alert Level of 200 $\mu g/m^3$.

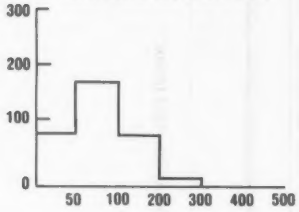
Source: U.S. Environmental Protection Agency, "Guidelines for Public Reporting of Daily Air Quality—Pollutant Standard Index."

Figure 1–1

Status of Air Quality in 41 SMSAs Using PSI Data, 1977

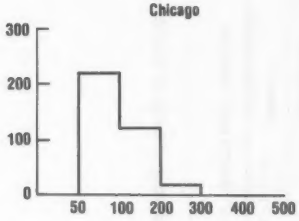
SMSAs where carbon monoxide (CO) is predominant problem

Anaheim-Santa Ana-Garden Grove



Pollutant	Days in PSI interval 100-200	200-300	>300
CO	44	9	
Oxidants	33	8	
TSP	1		
	78	17	

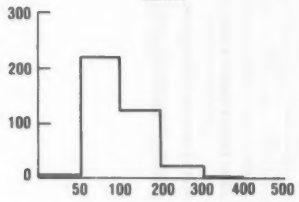
Chicago



CO	89	1	
Oxidants	18	5	
NO_2	0	1	
SO_2	3	0	
TSP	13	10	1
$SO_2 \times$ TSP	0	1	
	123	18	1

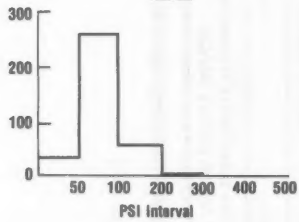
Days in PSI interval

Denver



CO	109	18	
TSP	7	2	1
Oxidants	6		
	122	20	1

Detroit

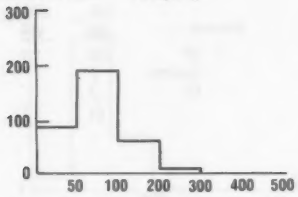


CO	41	1
Oxidants	15	1
TSP	6	
	62	2

Figure 1–1 (continued)

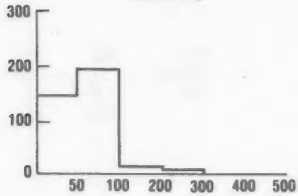
CO as predominant problem

Jersey City



Pollutant	Days in PSI interval 100-200	200-300	>300
CO	61	8	
Oxidants	5		
	66	8	

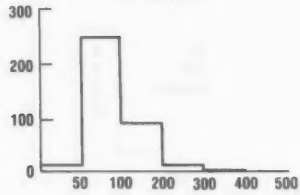
Kansas City



CO	5	6	
TSP	5	2	
SO_2	4		
Oxidants	3		
	17	8	

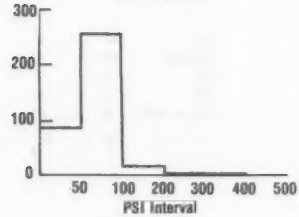
Days in PSI interval

Louisville



CO	54	9	
Oxidants	29	4	
TSP	5		
SO_2	2		
	90	13	

Memphis

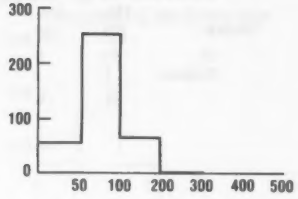


CO	10	1	
Oxidants	9		
TSP	0	1	1
	19	2	1

Figure 1–1 (continued)

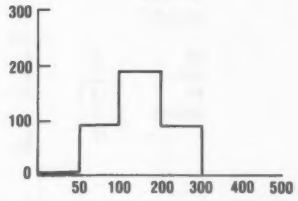
CO as predominant problem

Nashville-Davidson



Pollutant	Days in PSI interval 100-200	200-300	>300
CO	53	1	
Oxidants	6		
SO_2	2		
	61	1	

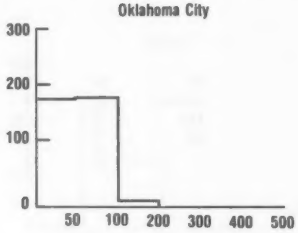
New York



CO	165	82	
Oxidants	21	3	
TSP	0	1	1
	186	86	1

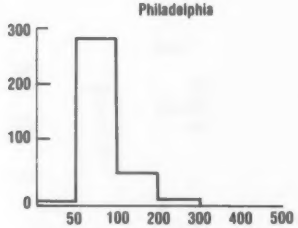
Days in PSI Interval

Oklahoma City



CO	8	
TSP	2	0
Oxidants	1	
	11	0

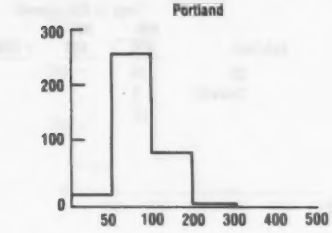
Philadelphia



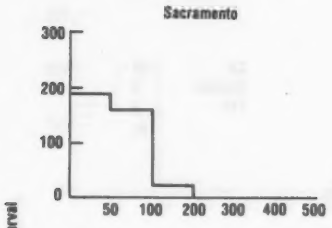
CO	44	3
Oxidants	20	1
SO_2	4	
TSP	1	1
$SO_2 \times$ TSP	0	5
	69	10

Figure 1–1 (continued)

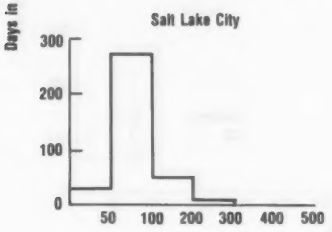
CO as predominant problem



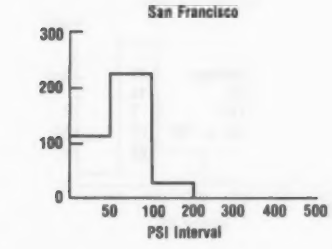
Pollutant	Days in PSI interval 100-200	200-300	>300
CO	68	5	
Oxidants	7		
TSP	1		
	76	5	



CO	11
Oxidants	8
	19



CO	36	3
TSP	13	3
$SO_2 \times$ TSP	0	3
SO_2	3	
	52	9



CO	19
Oxidants	5
	24

Days in PSI interval

Figure 1–1 (continued)

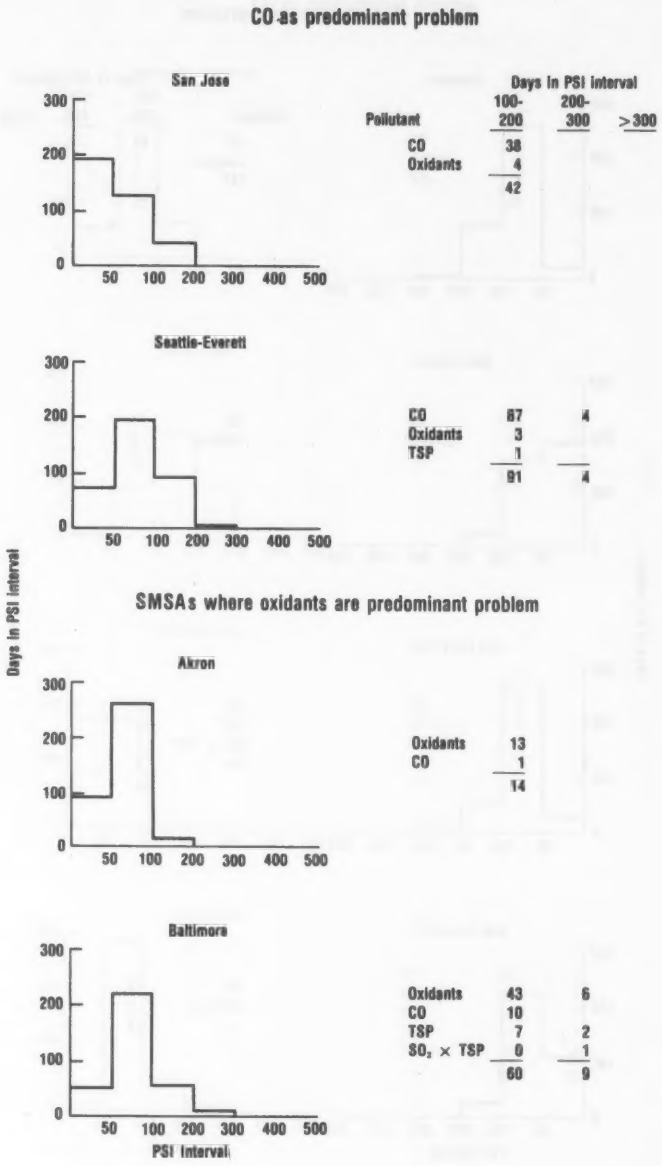
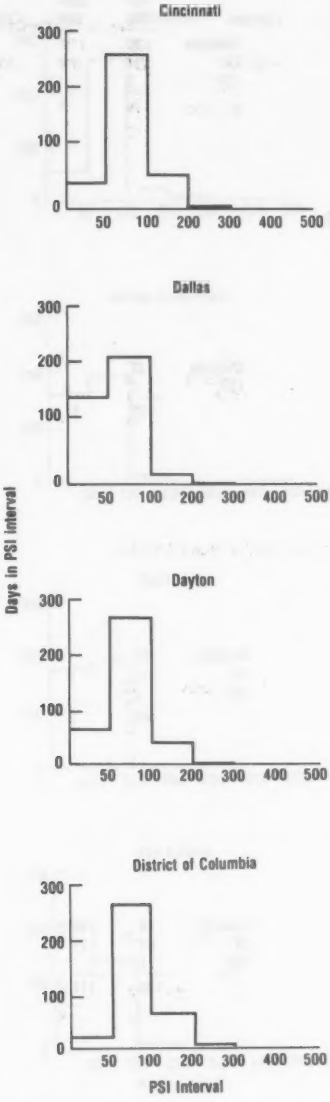


Figure 1–1 (continued)

Oxidants as predominant problem



Pollutant	Days in PSI interval 100-200	200-300	>300
Oxidants	49	2	
CO	6	2	
TSP	3		
SO_2	1		
	59	4	

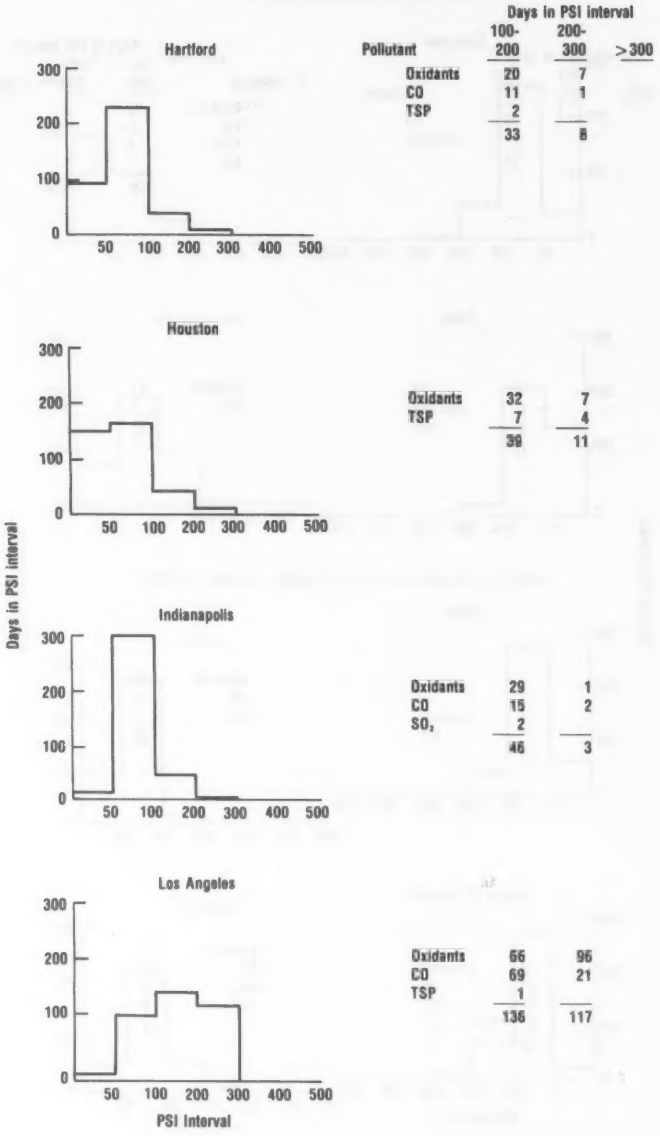
Oxidants	21		
TSP	2	1	
	23	1	

Oxidants	29		
CO	6	1	
NO_2	1		
	36	1	

Oxidants	51	5	
CO	12		
NO_2	0	1	
TSP	4	3	
	67	7	

Figure 1–1 (continued)

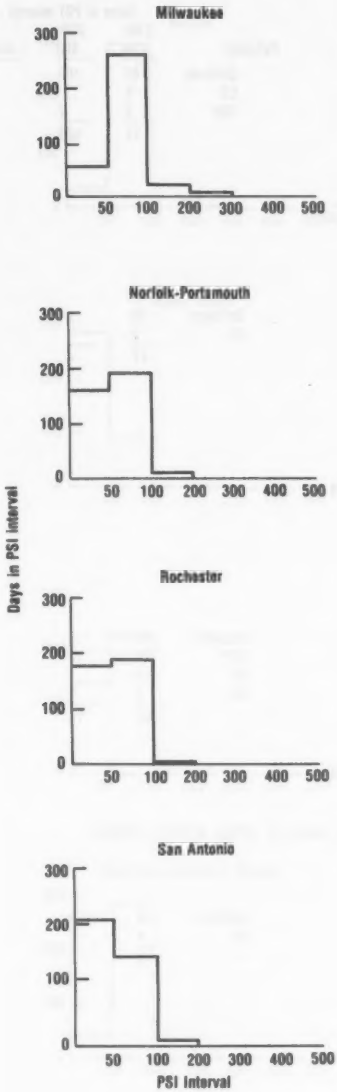
Oxidants as predominant problem



	Pollutant	Days in PSI interval 100-200	200-300	>300
Hartford	Oxidants	20	7	
	CO	11	1	
	TSP	2		
		33	8	
Houston	Oxidants	32	7	
	TSP	7	4	
		39	11	
Indianapolis	Oxidants	29	1	
	CO	15	2	
	SO_2	2		
		46	3	
Los Angeles	Oxidants	66	96	
	CO	69	21	
	TSP	1		
		136	117	

Figure 1–1 (continued)

Oxidants as predominant problem



Milwaukee

Pollutant	Days in PSI Interval 100–200	200–300	>300
Oxidants	15	1	
TSP	5	4	
CO	2	2	
SO_2	4		
	26	7	

Norfolk-Portsmouth

Oxidants	6
SO_2	3
	9

Rochester

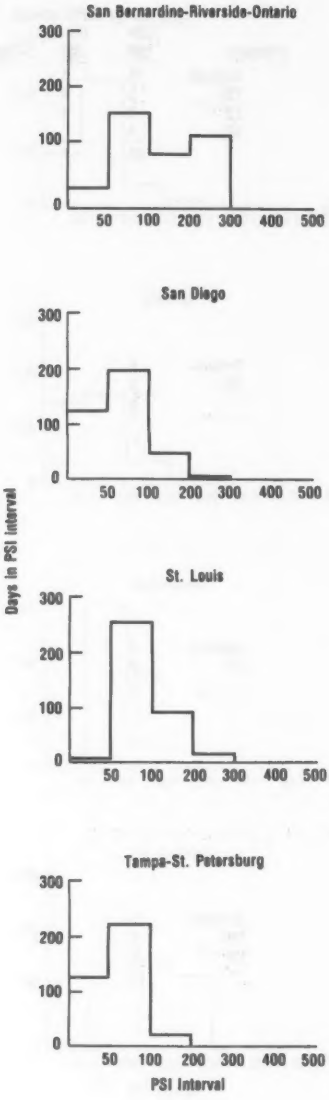
Oxidants	2
CO	2
	4

San Antonio

Oxidants	5
TSP	4
CO	2
	11

Figure 1–1 (continued)

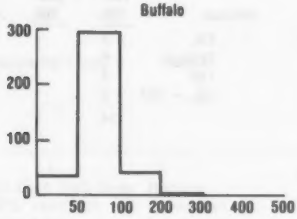
Oxidants as predominant problem



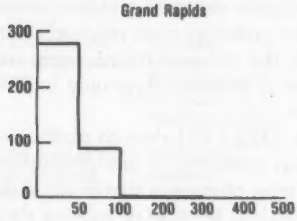
Pollutant	Days in PSI interval 100-200	200-300	>300
San Bernardino-Riverside-Ontario			
Oxidants	67	106	
CO	5		
TSP	2	2	
	74	108	
San Diego			
Oxidants	32	4	
CO	9		
	41	4	
St. Louis			
Oxidants	40	2	
TSP	24	10	
CO	23		
SO_2	3	1	
	90	13	
Tampa-St. Petersburg			
Oxidants	15		
CO	4		
	19		

Figure 1–1 (continued)

SMSAs where total suspended particulates (TSP) are predominant problem

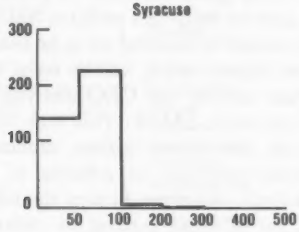


Pollutant	Days in PSI interval 100-200	200-300	>300
TSP	21	3	
Oxidants	11		
CO	4		
SO_2	1		
	37	3	



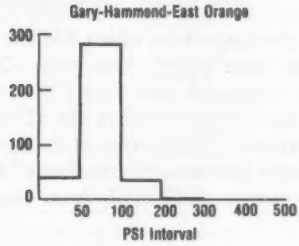
TSP	0	1
Oxidants	1	
	1	1

Days in PSI interval



TSP	2	2
CO	2	
Oxidants	1	
	5	2

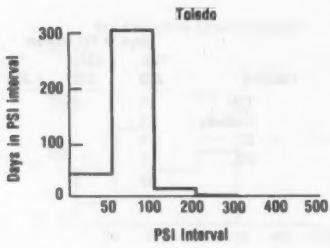
SMSAs where sulfur dioxide (SO_2) is predominant problem



SO_2	11	
Oxidants	9	1
TSP	8	
CO	2	
	30	1

Figure 1–1 (continued)

SO_2 as predominant problem



Pollutant	Days in PSI intervals 100-200	200-300	>300
SO_2	7		
Oxidants	5		
TSP	2		
$SO_2 \times$ TSP	0	1	
	14	1	

In only 3 of the 41 SMSAs—Buffalo, Syracuse, and Grand Rapids—was total suspended particulates the chief problem pollutant. In Syracuse and Grand Rapids, the problems were relatively minor: 4 days and 1 day, respectively, in the unhealthful or worse range. Sulfur dioxide was the chief cause of problem days only in Toledo and Gary-Hammond-East Chicago.

Although it is reasonable to use CEQ's PSI data to rank cities in terms of their relative air pollution problems, a few precautionary statements are in order. First, and most obvious, a significant number of SMSAs are omitted from the analysis because of missing data in the EPA data bank due to late reporting by states. Second, variations in weather from year to year can cause great variation in pollution readings, especially for the smaller, and normally less polluted SMSAs. Data for any single year, therefore, cannot be counted on to be exactly typical. Third, some local agencies report index values on a sub-regional level, while the daily values used in the CEQ analysis are based on the worst PSI values in an entire SMSA. This may mean that if a region has a predominant downtown carbon monoxide problem, as Manhattan does, ozone problems in suburbs of the SMSA will not show up in the analysis. All these factors should be kept in mind when looking at a list of cities ranked by order of severity of air pollution.

With these caveats in mind, CEQ has roughly ranked 42 SMSAs as shown in Table 1–2, using 3 years of data where possible.* The cities are arranged in five general groups, within which SMSAs are listed in alphabetical order. As the chart shows, three cities—New York, Los Angeles, and Cleveland—averaged more than 220 days—60 percent—in the unhealthful range. However, 15 of the 42 cities averaged less than 30 days in this category. As the range of the figures on which the 3-year average was based indicates, the number of days in the "unhealthful" category can change significantly from year to year.

*The 3-year data are based on the *current* PSI, which includes the present ozone standard of 0.12 ppm, not the former one of 0.08 ppm.

Table 1–2

Ranking of Standard Metropolitan Statistical Areas (SMSAs) Using Pollutant Standard Index (PSI) Air Pollution Data, 1975–77

Severity Class	SMSA	Number of "Unhealthful" Days (PSI over 100)		Number of "Very Unhealthful" Days (PSI over 200)	
		3-year average	Minimum-maximum annual days during 3 years	3-year average	Minimum-maximum annual days during 3 years
I					
(More than 150 days of PSI readings above 100)	Denver	157	143–182	30	20–37
	Cleveland	[a] 225	228–229	[a] 41	12–59
	Los Angeles	264	253–272	132	117–142
	Louisville	150	104–185	20	14–31
	New York	[b] 273	—	[b] 87	—
	Riverside	193	174–224	106	88–122
II					
(100–150 days of PSI readings above 100)	Anaheim	120	95–134	38	17–58
	Chicago	139	81–195	21	14–31
	Philadelphia	103	79–143	12	7–19
	St. Louis	123	97–141	21	13–33
	Washington, D.C.	110	74–147	16	7–26
III					
(50–100 days of PSI readings about 100)	Baltimore	[a] 64	49–79	[a] 18	10–25
	Houston	54	48–64	9	4–12
	Jersey City	[b] 74	—	[b] 8	—
	Nashville	59	39–76	3	1–5
	Portland	78	70–83	7	3–13
	Salt Lake City	82	61–110	18	9–25
	San Diego	59	45–74	6	4–9
	San Jose	58	42–81	8	0–21
	Seattle	86	73–95	5	4–5
IV					
(25–50 days of PSI readings above 100)	Buffalo	41	31–51	7	3–11
	Cincinnati	41	20–63	2	1–4
	Dallas	26	18–35	1	0–2
	Dayton	[a] 33	29–37	[a] 1	1–2
	East Chicago	29	27–31	—	—
	Hartford	34	25–41	6	3–8
	Indianapolis	[a] 33	17–49	[a] 2	1–3
	Milwaukee	35	32–40	8	7–8
	Sacramento	26	19–38	1	0–3
	San Francisco	33	24–45	1	0–2
V					
(0–25 days of PSI readings above 100)	Akron	[b] 14	—	[b] 0	—
	Grand Rapids	[a] 3	1–8	[a] 0	0
	Honolulu	[a] 0	0–1	[a] 0	0
	Kansas City	12	5–23	3	0–8
	Memphis	24	19–24	3	0–7
	Norfolk	13	9–16	1	0–2
	Oklahoma City	[b] 11	—	[b] 0	—
	Rochester	5	2–8	0	0
	San Antonio	[a] 10	8–11	[a] 0	0
	Syracuse	6	5–7	1	0–2
	Tampa	11	5–19	1	0–1
	Toledo	[a] 21	14–25	[a] 1	1–1

[a] Based on only 2 years of data.
[b] Based on only 1 year of data.

Source: Data supplied by the U.S. Environmental Protection Agency.

NATIONAL POPULATION EXPOSURE TO AIR POLLUTION

Although much useful information can be derived from the analysis of city-by-city air quality monitoring data alone, such analysis does not indicate how many people are exposed to various levels of pollution across the nation. To fill this gap, CEQ has developed two models that relate air pollution monitoring data and population statistics as a means of estimating the nation's exposure to air pollution. The first, the CEQ Air Pollution Health Risk Model, focuses on city-by-city case studies and was discussed in the Ninth Annual Report.[6] That model not only estimates population exposure, but also estimates specific health damages to susceptible groups within the total urban populations.

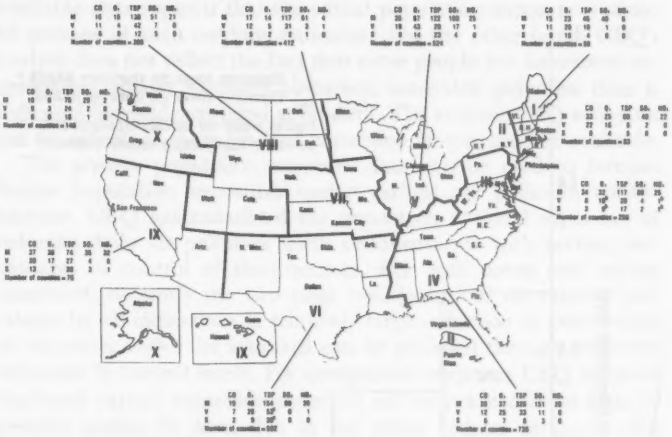
The second model, reported on here, examines actual population exposures (measured in person-days of exposure to pollution levels at or above ambient air quality standards) in comparison to total possible national exposure to the criteria pollutants. The analysis provides a means of comparing the relative severity of the risk to the population posed by one pollutant relative to another. In general, it suggests that the magnitude of the problem created by carbon monoxide and ozone is appreciably greater than that caused by the other three criteria pollutants.

CEQ's analysis is based on 1977 county-by-county monitoring data. For each county where monitoring data were available, CEQ multiplied the population of the county by the number of days on which the levels of each of the criteria pollutants exceeded the primary ambient air-quality standard; this yielded the number of person-days of exposure in the county for the year. CEQ then aggregated the county-by-county data to determine the total number of person-days of exposure to each pollutant in the nation. If no monitoring data were available from a county, CEQ assumed no person-days of exposure in that county occurred. CEQ made this assumption because, although a majority of U.S. counties lack monitoring stations, virtually all of the counties in which significant air pollution problems exist are adequately monitored. (Some rural areas where pollution levels are not monitored do experience a few low-grade violations of the ozone standard, particularly in the Northeast. However, because these exposures are infrequent and involve comparatively small populations, they would not have much effect on the results of CEQ's analysis, were they included.)

Figure 1–2 indicates the total number of counties in each federal region, as well as the number being monitored for each of the criteria pollutants. The figure also shows the number of counties monitored that experienced at least one violation of the various short-term standards in 1977, and also the number that experienced 10 or more days in violation. The latter figure gives some indication of the severity of the problem. For example, Region I, which includes Maine, Vermont, New Hampshire, Connecticut, Massachusetts, and Rhode Island, contains 59 counties, of which 15 monitor for carbon

Figure 1–2

Monitoring and Violation Information by County for the 10 Federal Regions, 1977 [a]



M = Number of counties with monitors.
V = Number of counties with violations.
S = Number of counties with 10 or more days greater than NAAQSs.

[a] Counties for which there are no 1977 data but for which 1974–76 data were used.
[b] No 1977 ozone data for most of Pennsylvania; 1976 data used.
[c] Arkansas 1975 data not used because information is questionable.

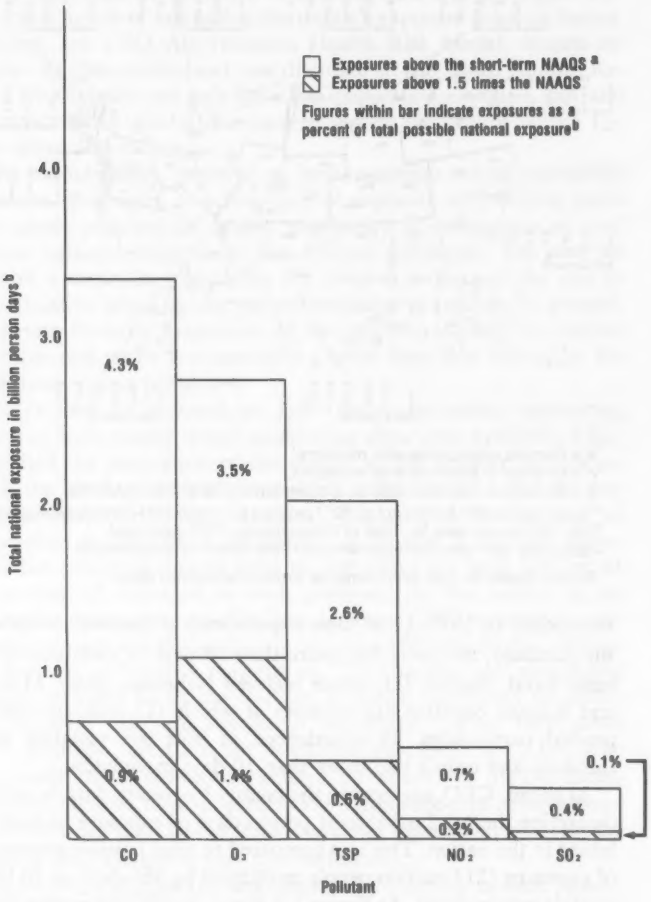
Source: Based on U.S. Environmental Protection Agency data.

monoxide. In 1977, 11 of these experienced at least one violation of the standard, and nine had more than 10 days in violation. On the other hand, Region III, which includes Nebraska, Iowa, Montana, and Kansas, contains 412 counties of which 117 monitor total suspended particulates, 31 experienced at least one violation of the standard and only 2 had more than 10 days in violation.

As noted, CEQ aggregated the county-by-county data in order to determine the total number of person-days of exposure to each pollutant in the nation. This was compared to total possible person-days of exposure (214 million people multiplied by 365 days, or 78 billion possible person-days). As Figure 1–3 shows, in 1977 the person-days of exposure to carbon monoxide were 4.3 percent of total possible national person-days of exposure to the pollutant, the highest for the five criteria pollutants. For ozone, this figure is 3.5 percent; for particulates, 2.6 percent; and for the remaining two pollutants, 0.7 percent or less. The data also indicate that a greater number of more severe exposures (person-days at one and a half times the primary standard) occurred for ozone than for the other pollutants.

Figure 1–3

Estimates of National Exposure to Pollutant Levels Above the Short-term Ambient Health-related Standards, 1977



[a] No_2 analysis based on exposures above 500 $\mu g/m^3$.
[b] Total possible national exposure equals 78 billion person days.
Source: Based on U.S. Environmental Protection Agency data.

The use of data from fixed monitors for this type of analysis has been questioned in terms of how well such data reflect actual human exposures. People are mobile. Their exposure to pollution varies as they commute in traffic, work indoors, walk next to heavy traffic, and

jog in the parklands. Although most of these relationships have yet to be quantified, CEQ has made some simplifying, but conservative assumptions in order to arrive at some upper-limit population exposure estimates now. For example, it is assumed that the entire population is exposed to outdoor pollution. A preliminary study of available data suggests that the actual population exposure is about 65 percent of such outdoor estimates.[7] On the other hand, CEQ's analysis does not reflect the fact that more people are downtown experiencing greater exposure to carbon monoxide pollution than is indicated by residence population data. The current CEQ estimates can be refined as these kinds of correction factors become available.

The present population exposure data can be used to forecast future population exposures under various air pollution control schemes. CEQ has calculated the impact on national exposures of reducing daily air pollution levels commensurate with certain percentages of control of their sources. For both ozone and carbon monoxide, currently the two most troublesome of the criteria pollutants by all indications, a relatively large reduction in person-days of exposures above the standard can be achieved through moderate advances in control levels. For comparison purposes, CEQ assumed that total carbon monoxide emissions will be reduced by at least 60 percent within 10 years due to the influx of cars equipped with catalytic-converters into the total car population.[8] As is shown in Figure 1–4, this change would reduce total person-days of exposure to carbon monoxide above the standard by 95 percent. The same car turnover could reduce hydrocarbon emissions, which are the primary cause of ozone formation, by about 40 percent.[9] Even without other controls on stationary emitters of hydrocarbons and other transportation control measures, this change in control level would reduce person-days of exposure to ozone by 75 percent by 1987.

URBAN TRENDS

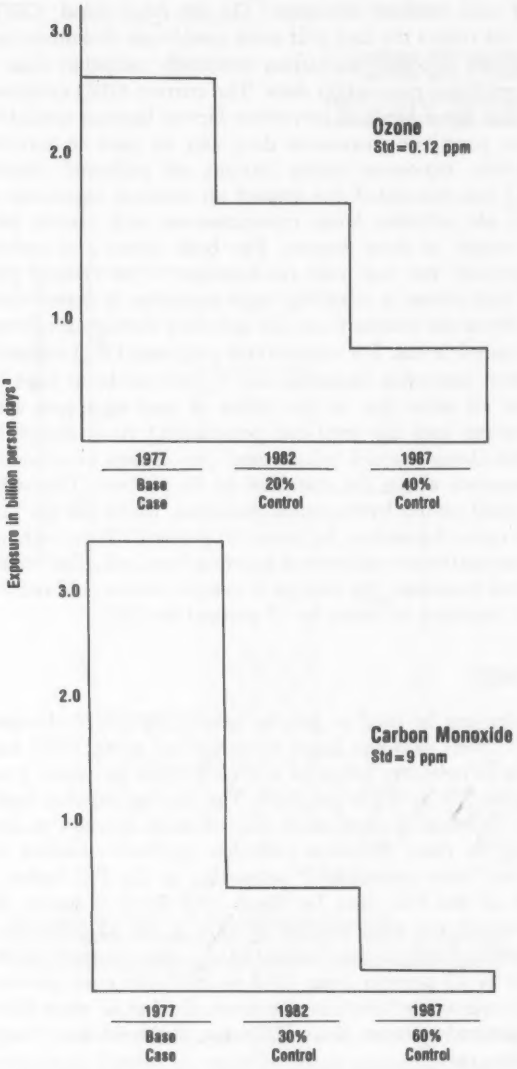
The PSI index can be used to gain an overall picture of changes in air pollution levels in many larger metropolitan areas. CEQ has analyzed trends in pollution levels for the 25 SMSAs for which 4 or 5 years of reliable PSI data are available. The analysis looks at both the frequency (number of days) that air pollution episodes occur, and the severity of those incidents (whether they are classified as "unhealthful" or "very unhealthful" according to the PSI index).

A composite of the PSI data for these 25 SMSAs is shown in Figure 1–5. Overall, the total number of days in the 25 cities that registered pollution levels in the "unhealthful" range (greater than 100) decreased by 15 percent from 1974 to 1977. An even greater decrease—32 percent—occurred in the total number of days that PSI levels registered greater than 200, the threshold for "very unhealthful" air quality.

The trends for each one of the 25 SMSAs are indicated in Figure 1–6. As the graph shows, it is in the more polluted SMSAs within

Figure 1–4

Estimates of Present and Future Population Exposure to Air Pollution Levels Above Current Ambient Ozone and Carbon Monoxide Standards

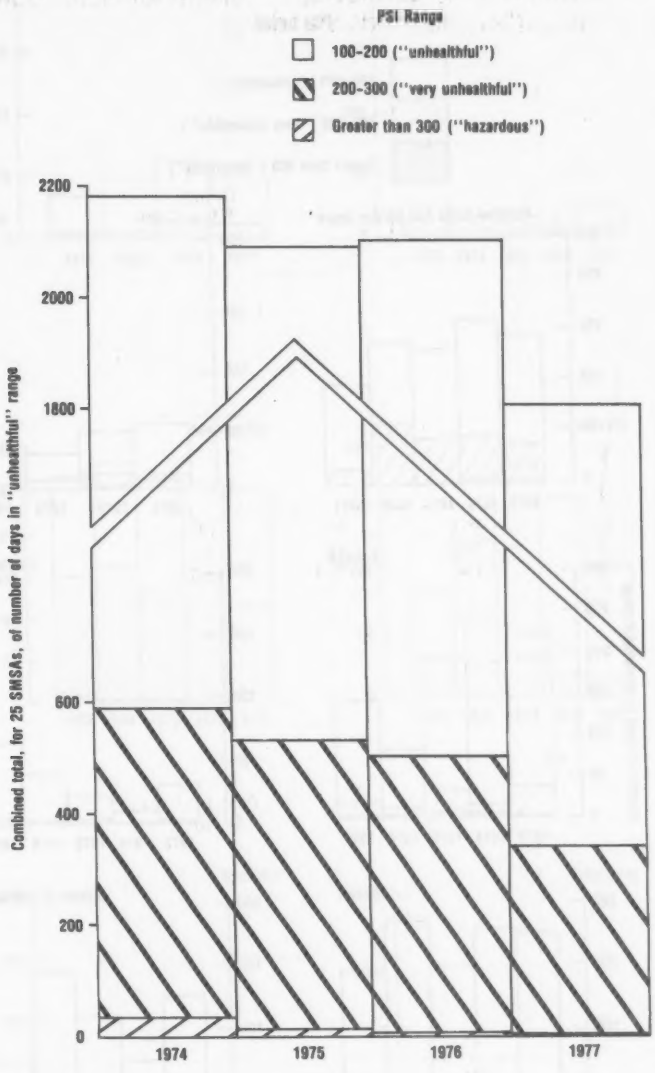


[a] Total possible exposure equals 78 billion person days.

Source: Based on U.S. Environmental Protection Agency data.

Figure 1–5

National Trend in Urban PSI Levels, 1974–77



Source: Based on U.S. Environmental Protection Agency data.

Figure 1–6

Trends in PSI Levels in 25 SMSAs, 1973–77

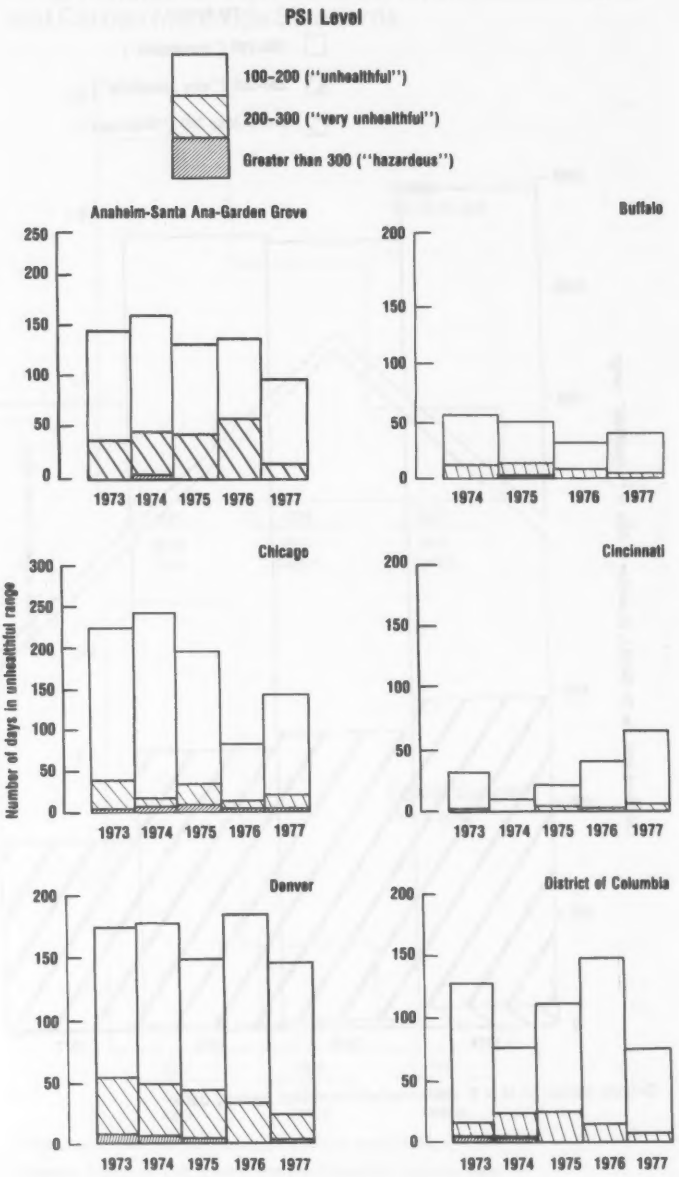


Figure 1–6 (continued)

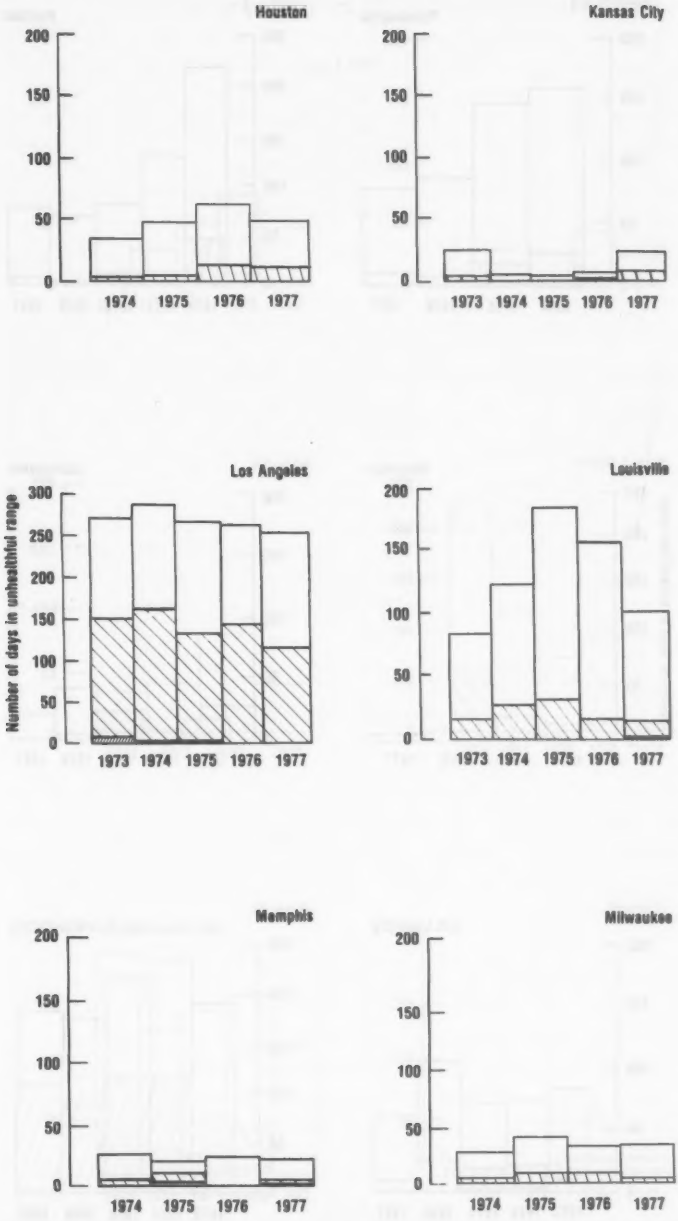


Figure 1–6 (continued)

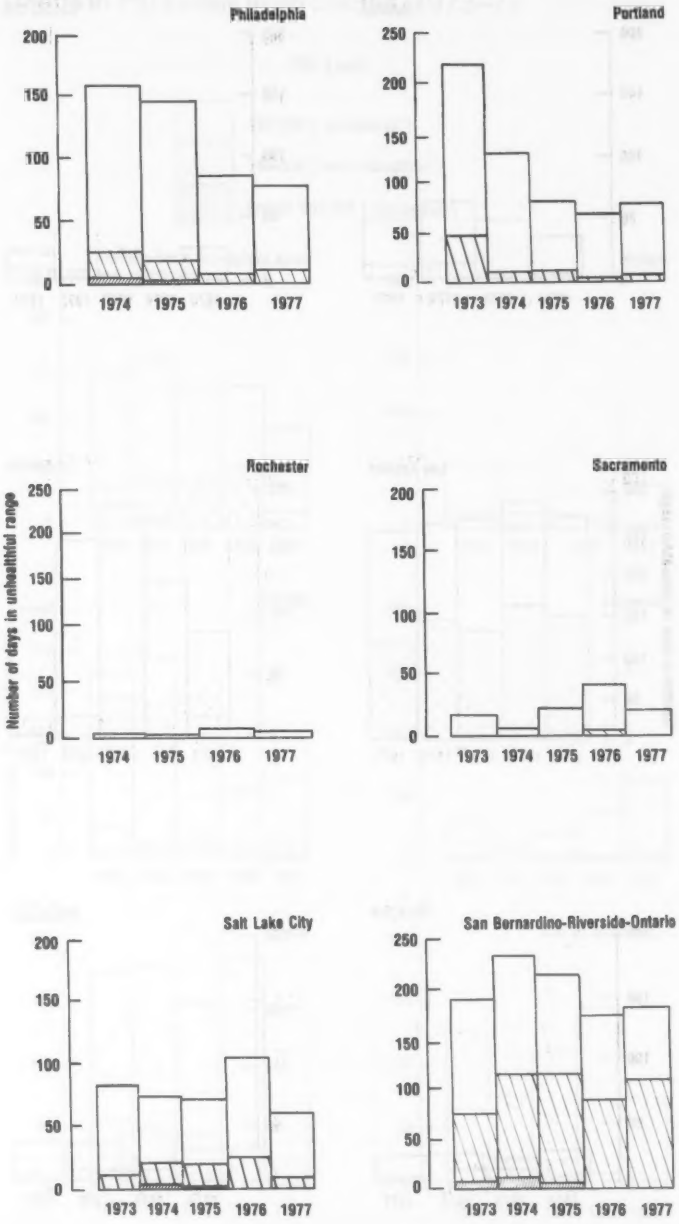


Figure 1–6 (continued)

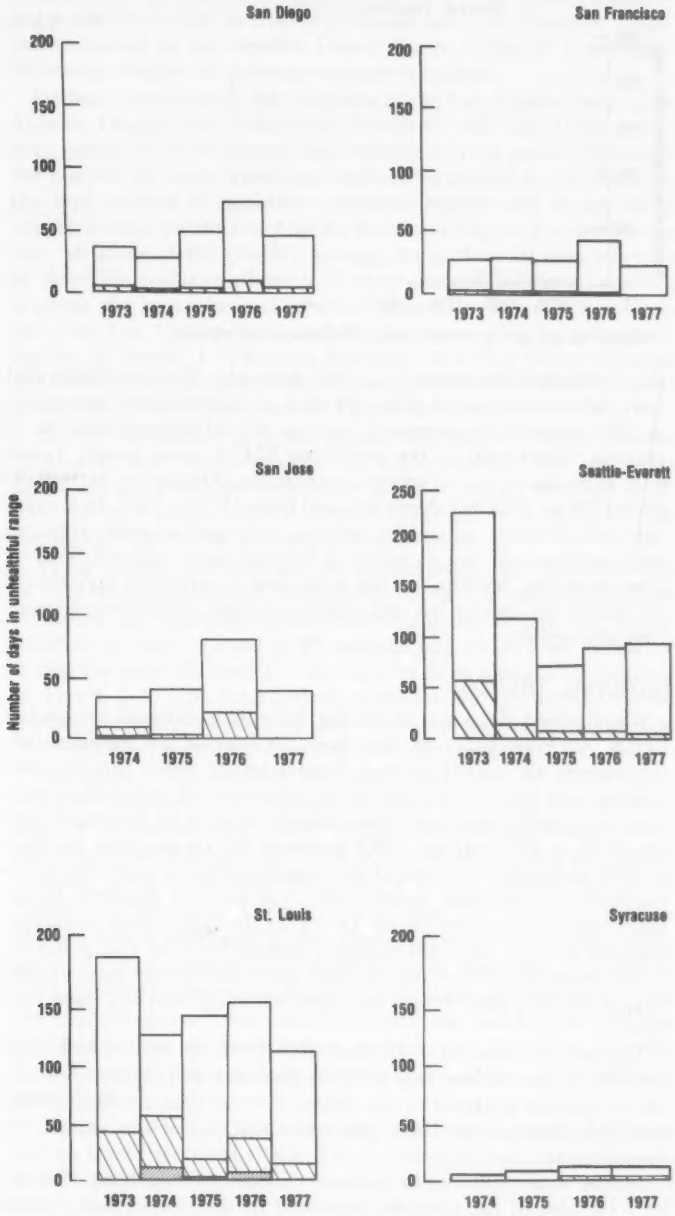
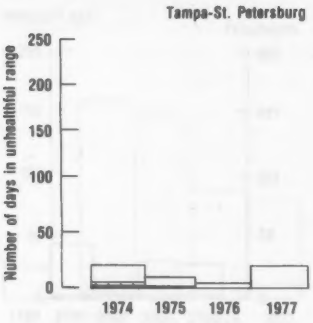


Figure 1–6 (continued)



Source: Based on U.S. Environmental Protection Agency data.

this group that improvement is most dramatic. All nine SMSAs that were experiencing more than 100 days of "unhealthful" air quality in 1974 showed improvement, and an overall improvement of 35 percent. The trends in the remaining SMSAs were mixed. Louisville experienced an apparent increase in unhealthful air quality from 1973 to 1975 but then a reversal from 1975 to 1977. In Cincinnati and Houston, air quality appears to be getting worse although their problems are not as severe as the nine most polluted SMSAs. The remaining SMSAs for the most part experienced unhealthful air quality 50 days or less and neither upward or downward trends were discernible.

NATIONAL TRENDS

County-level data are useful for indicating national air-quality trends. An examination of data from the four or five counties with the poorest air quality in each federal region shows that in most regions, and for most pollutants, the frequency of violations of ambient air quality standards either stayed constant or decreased over the 1974 to 1977 period. CEQ analyzed the county data for four criteria pollutants in terms of the number of times pollution levels exceeded two different benchmarks: the ambient standard and a higher pollutant concentration. Levels for the fifth criteria pollutant, nitrogen dioxide, were not analyzed because levels of that pollutant in the atmosphere have not changed much during the past 5 years, due to the fact that control strategies have only recently gone into effect.

Figures 1–7 through 1–10 show the results of the analysis. The numbers in parentheses next to the region number indicate the number of counties analyzed in the region, if fewer than the four or five specified. Regions have been grouped by section of the country for visual clarity.

Ozone levels appear not to have changed greatly from 1974 to 1977 in most of the counties monitored in the eastern and central

United States, although there appeared to be an increase in number of days above the standard in Region III—the Mid-Atlantic States—and a significant drop in Region VII—the Midwest. However, counties examined in the western United States displayed a generally decreasing number of violations of ozone standards.

Despite improvement, the problems in the Los Angeles Basin (Los Angeles, Orange, San Bernardino, Riverside, and San Diego counties) remain far more serious than elsewhere in the nation. Although the number of severe violations declined somewhat in Los Angeles, the total number of violations remained higher than in any other region. Except for the Los Angeles Basin and Region I in the Northeast, all areas of the country average fewer than 10 days per year of ozone air pollution above 0.16 parts per million (ppm) (which is about the lower limit of observed adverse health effects). However, the Los Angeles Basin and the five areas with the poorest air quality in Region I (Fairfield, Hartford, and New Haven counties in Connecticut, the area south of Boston, and Boston itself) average more than 30 days above the 0.12 ppm standard.

Carbon monoxide has shown marked improvement in the counties monitored, with the greatest change evident in the East. Nevertheless, violation levels are still rather high, averaging from 40 to 90 days per year in the western areas studied, and from 20 to 60 days per year for the central and eastern U.S. counties.

Sulfur dioxide problems are not widespread in the United States; of 753 counties monitored in the nation for this pollutant, fewer than 50 showed any violations of the 24-hour primary ambient air quality standard in 1977. A total of 25 counties had 10 or more violations during the years 1975 to 1977; the data for these counties are reflected in Figure 1–9. The most serious problems are attributable to the smelting industry, which in general has been slow to meet emission limitations but is gradually coming into compliance.

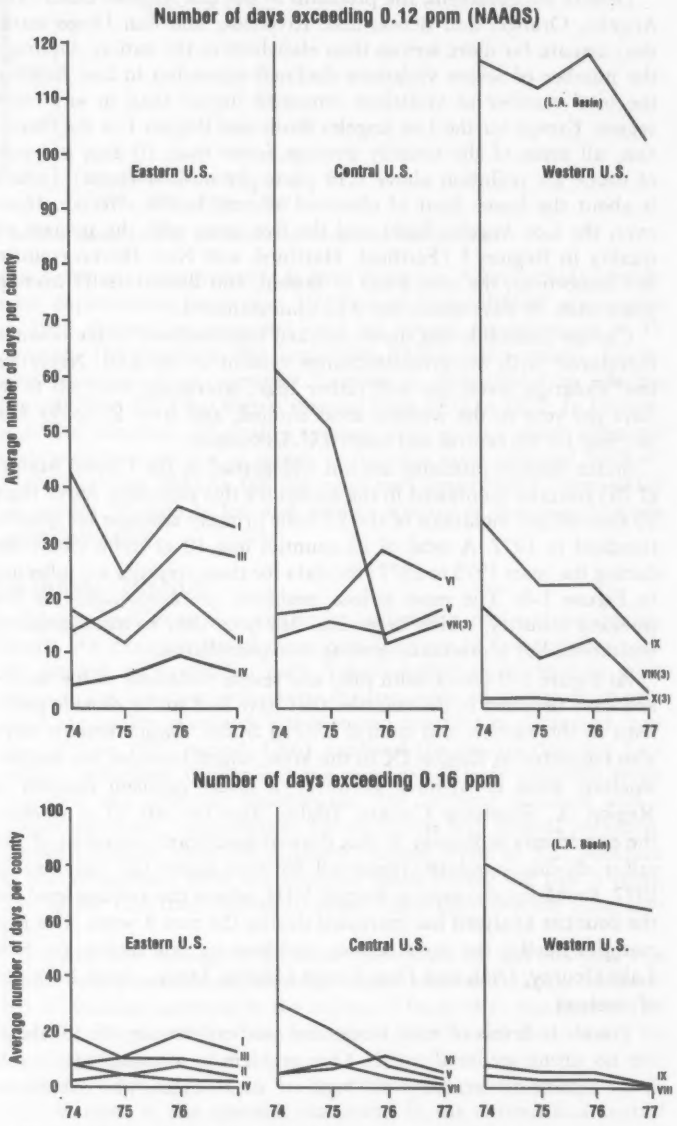
As Figure 1–9 shows, both total and severe violations of the standard have declined in the counties that have had sulfur dioxide problems in the eastern and central United States. Improvements were also registered in Region IX in the West, which includes the copper-smelting areas in Arizona. However, a severe problem remains in Region X. Shoshone County, Idaho, also the site of a smelter, the one county in Region X that showed significant violations of the sulfur dioxide standard, registered 85 days above the standard in 1977. Problems also exist in Region VIII, where the average level for the counties analyzed has increased during the past 4 years. The two counties having the most serious problems in this region are Salt Lake County, Utah and Deer Lodge County, Mont.—both locations of smelters.

Trends in levels of total suspended particulates are mixed, showing no strong sectional trends. One problem in assessing such levels is the significant incidence of "fugitive" dust—created by duststorms

Figure 1–7

Trends in Ozone Standard Violations, by EPA Region, 1974–77

(for 5 worst counties in region)

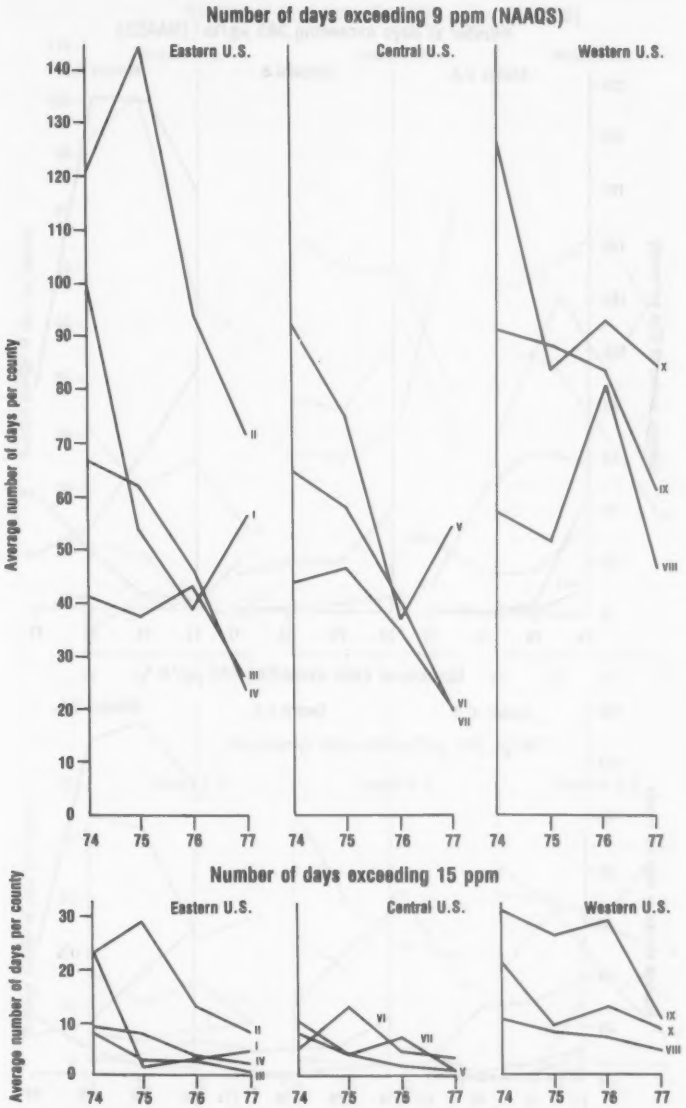


Source: Based on U.S. Environmental Protection Agency data.

Figure 1–8

Trends in Carbon Monoxide Standard Violations, by EPA Region, 1974–77

(for 4 worst counties in region)

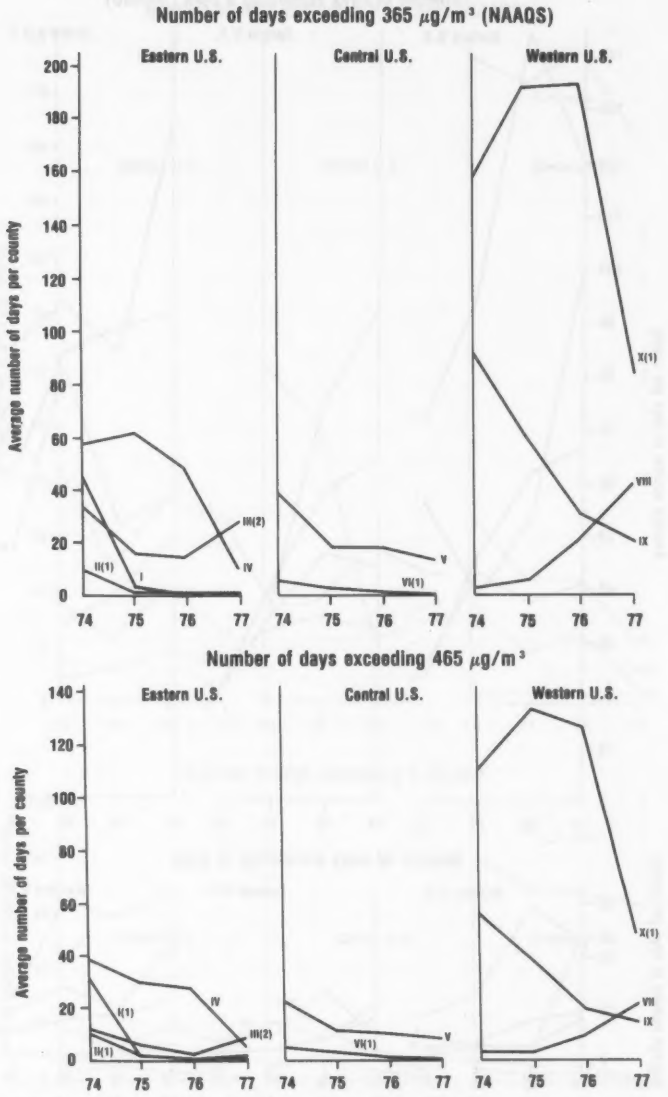


Source: Based on U.S. Environmental Protection Agency data.

Figure 1–9

Trends in Sulfur Dioxide Standard Violations, by EPA Region, 1974–77

(for 4 worst counties in region)

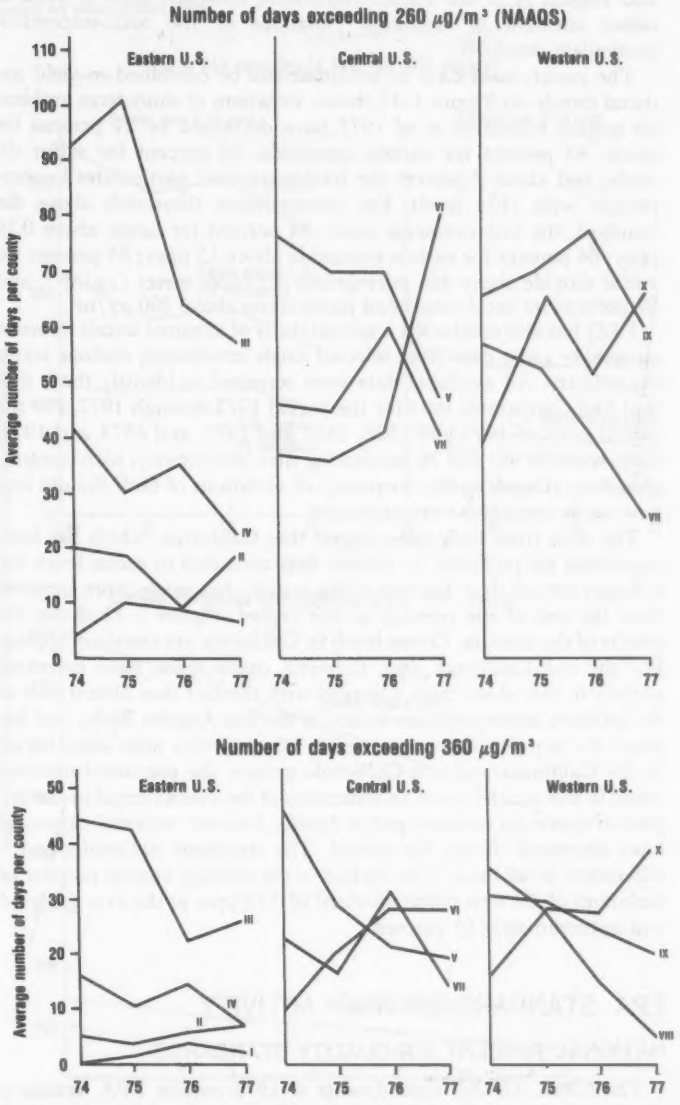


Source: Based on U.S. Environmental Protection Agency data.

Figure 1–10

Trends in Total Suspended Particulates Standard Violations, by EPA Region, 1974–77

(for 5 worst counties in region)



Source: Based on U.S. Environmental Protection Agency data.

and windblown roadway and agricultural dirt, and "reintrained" dust—particulates deposited on paved streets and then resuspended in the air by auto and truck traffic. For example, the significant increase registered in Region VI was due to a major dust storm in February 1977, according to EPA.[10] Most regions except Region VI and Region X in the Pacific Northwest, however, show a trend of either constant or declining violations of the total-suspended-particulate standard.

The county-level data by pollutant can be combined to yield national trends. As Figure 1–11 shows, violations of short-term ambient air quality standards as of 1977 have decreased by 24 percent for ozone, 43 percent for carbon monoxide, 54 percent for sulfur dioxide, and about 2 percent for total suspended particulates in comparison with 1974 levels. For concentration thresholds above the standard, the improvements were: 34 percent for ozone above 0.16 ppm; 64 percent for carbon monoxide above 15 ppm; 65 percent for sulfur dioxide above 465 micrograms per cubic meter ($\mu g/m^3$), and 27 percent for total suspended particulates above 360 $\mu g/m^3$.

CEQ has also conducted a special study of national trends in ozone air quality using data from selected single monitoring stations across the country. All available data were screened to identify those sites that had comparable data for the period 1973 through 1977. For the paired years of 1973 and 1976, 1973 and 1977, and 1974 and 1977, there were 54, 48, and 76 monitoring sites, respectively, with comparable data. Trends in the frequency of violations of both the old and new ozone standards were examined.

The data from these sites suggest that California, which has been regulating air pollution to achieve improvements in ozone levels for a longer period than the rest of the nation, has made more progress than the rest of the country in this regard. Figure 1–12 shows the results of the analysis. Ozone levels in California are clearly dropping. For the non-California sites, however, ozone levels have increased slightly in five of six cases. Coupled with the fact that almost half of the nation's ozone exposure occurs in the Los Angeles Basin, and because the populations represented by the monitors were about equal in the California and non-California groups, the combined national trend in this analysis gives an indication of the overall trend in the impact of ozone on national public health. Overall, national exposures have decreased during the period. The combined national trend is downward in all cases. The decline in the average annual number of violations of the new ozone standard of 0.12 ppm at the sites analyzed was approximately 13 percent.

EPA STANDARD-SETTING ACTIVITY

NATIONAL AMBIENT AIR-QUALITY STANDARDS

The Clean Air Act amendments of 1977 require EPA to take a new look at the standards for ambient air quality for the five principal

Figure 1–11

National Trends in Ozone, Carbon Monoxide, Sulfur Dioxide and Total Suspended Particulates Standard Violations, 1974–77

(based on county-level data)

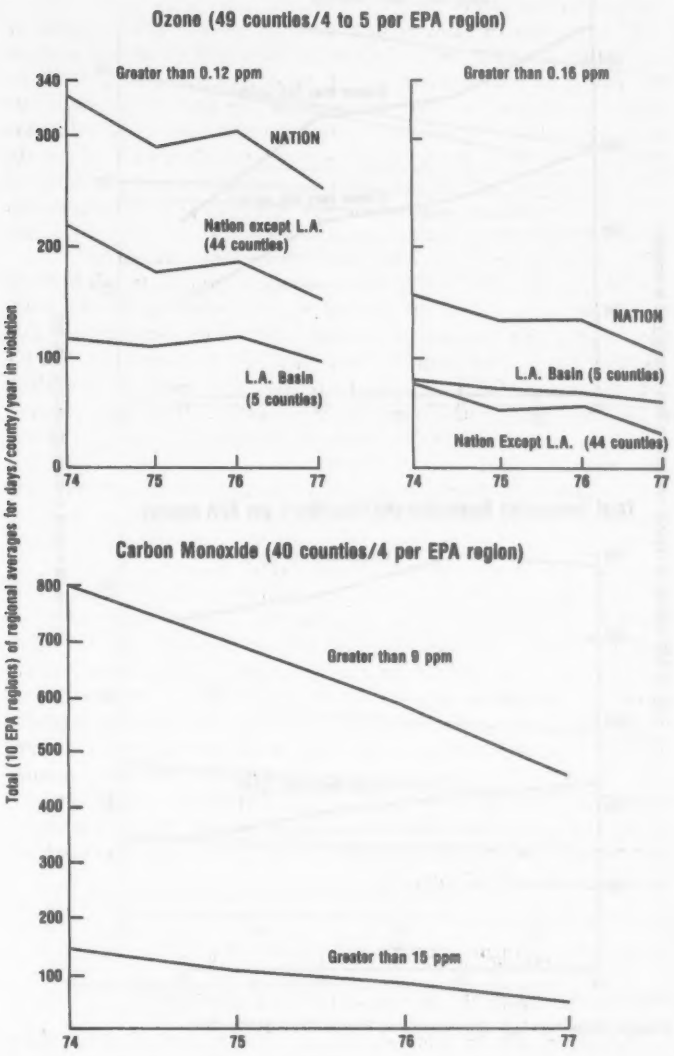
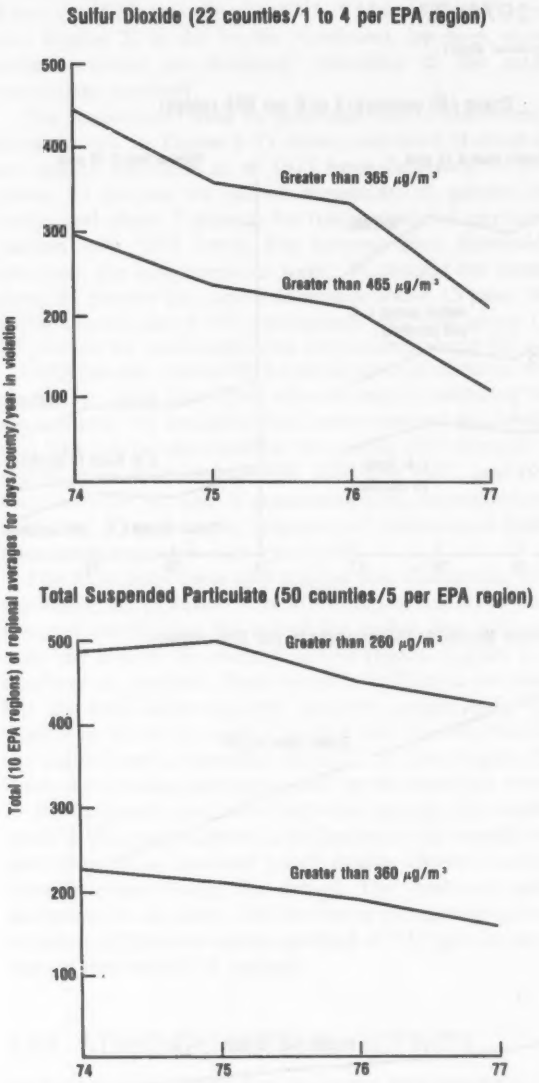


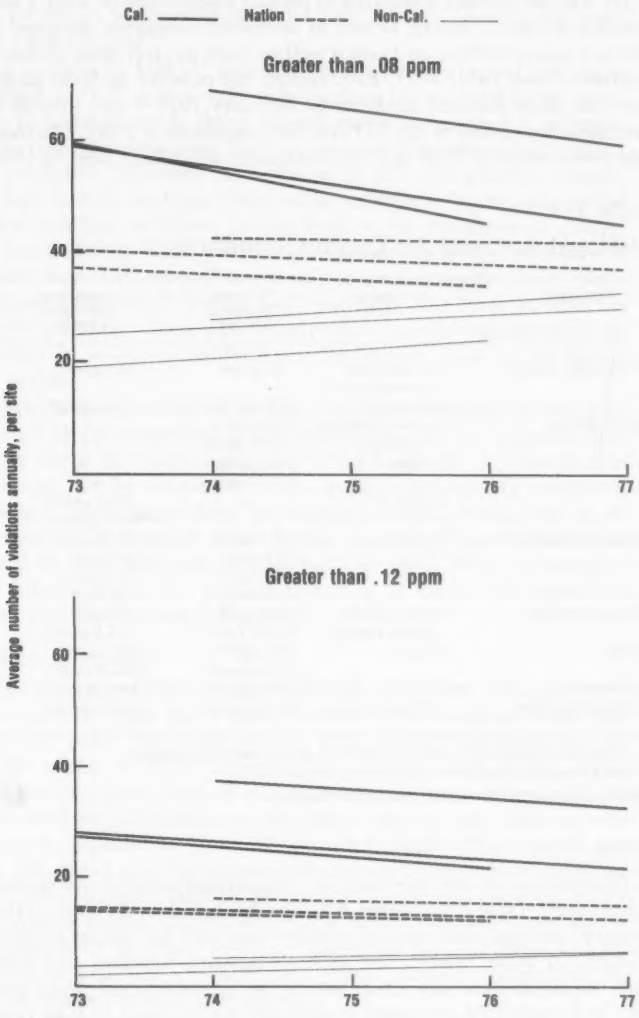
Figure 1–11 (continued)



Source: Based on U.S. Environmental Protection Agency data.

Figure 1–12

Trends in Ozone Standard Violations at Selected Sites in California and the Nation, 1973–77



Source: Based on U.S. Environmental Protection Agency data.

"criteria" air pollutants: photochemical oxidants (or ozone) (O_3), carbon monoxide (CO), sulfur dioxide (SO_2), total suspended particulates (TSP) and nitrogen dioxide (NO_2). The deadline for completing the review is the end of 1980.[11] For all of these pollutants, EPA has set primary standards to protect human health with a reasonable margin of safety, as well as secondary standards, designed to protect against effects on human welfare such as crop losses or metal corrosion (see Table 1–3). EPA revised the primary ambient standard for photochemical oxidants in February 1979 [12] and intends to complete the review of the CO and NO_2 standards in 1980. The more complex review of TSP and SO_2 standards will follow later in 1980.

Table 1–3

National Ambient Air Quality Standards

Pollutant	Averaging Time	Primary Standard Levels	Secondary Standard Levels
Particulate matter	Annual (geometric mean)	75 μg/m³	60 μg/m³
	24 hours [b]	260 μg/m³	150 μg/m³
Sulfur oxides	Annual (arithmetic mean)	80μg/m³ (0.03 ppm)	—
	24 hour [b]	365 μg/m³ (0.14 ppm)	—
	3 hour [b]	—	1300 μg/m³ (0.5 ppm)
Carbon monoxide	8 hour [b]	10 mg/m³ (9 ppm)	10 mg/m³ (9 ppm)
	1 hour [b]	40 mg/m³ (35 ppm)	40 mg/m³ (35 ppm)
Nitrogen dioxide	Annual (arithmetic mean)	100 μg/m³ (0.05 ppm)	100 μg/m³ (0.05 ppm)
Ozone	1 hour [b]	235 μg/m³ (0.12 ppm)	235 μg/m³ (0.12 ppm)
Hydrocarbons (nonmethane) [a]	3 hour (6 to 9 a.m.)	160 μg/m³ (0.24 ppm)	160 μg/m³ (0.24 ppm)

[a] A nonhealth related standard used as a guide for ozone control.
[b] Not to be exceeded more than once per year.
Source: U.S. Environmental Protection Agency.

Ozone

The revision of the standard for photochemical oxidants engendered considerable controversy. EPA first proposed its revisions in the primary national ambient air quality standard for photochemical oxidants in June 1978.[13] The existing primary standard was 0.08 ppm averaged over one hour, not to be exceeded more than one time in a year. EPA proposed to increase the standard to 0.10 ppm not to be exceeded more than one time per year, and to base the standard on ozone rather than on photochemical oxidants. (Photochemical oxidants are approximately 90 percent ozone).[14]

EPA made its proposal on the basis of a critical review of the available data on health effects. These data suggest that adverse

effects occur beginning at exposures in the range of 0.15 to 0.25 ppm.[15] EPA proposed that the standard be set below this range in order to provide a margin of safety.

On January 26, 1979, Douglas Costle, Administrator of EPA, announced the final primary and secondary ambient air quality standards for ozone, which were set at 0.12 ppm, not to be exceeded more than 1 day per year.[16]

An analysis by CEQ[17] indicates that the relaxation of the ozone standard to 0.12 ppm would only increase future population exposures to ozone to levels above the old standard by about 11 percent. At the concentrations most likely to affect health—above 0.15 ppm—the predicted difference in exposure is only 0.3 percent. Assuming that control strategies designed to achieve a 46 percent control of hydrocarbon emissions (which lead to the formation of ozone) are implemented, CEQ projects that within 10 years, exposures to greater than 0.15 ppm of ozone will occur only in the South Coast Basin of California.[18] Figure 1–13 compares this forecast with the present situation. These data clearly show that the magnitude of the problem in southern California is far greater than in the rest of the nation.

EPA cost estimates show that the 0.12 ppm standard, as compared with a 0.08 ppm standard, will reduce direct costs for pollution control by about $2.7 billion per year.[19] The Clean Air Act directs that costs can not be considered when setting the primary standards. However, when establishing the margin of safety, it may not be inappropriate to consider other factors including benefits and costs. The 0.12 ppm standard is an important goal. When achieved, it will bring about a 92.5 percent reduction in the overall population exposure to levels above 0.15 ppm.[20]

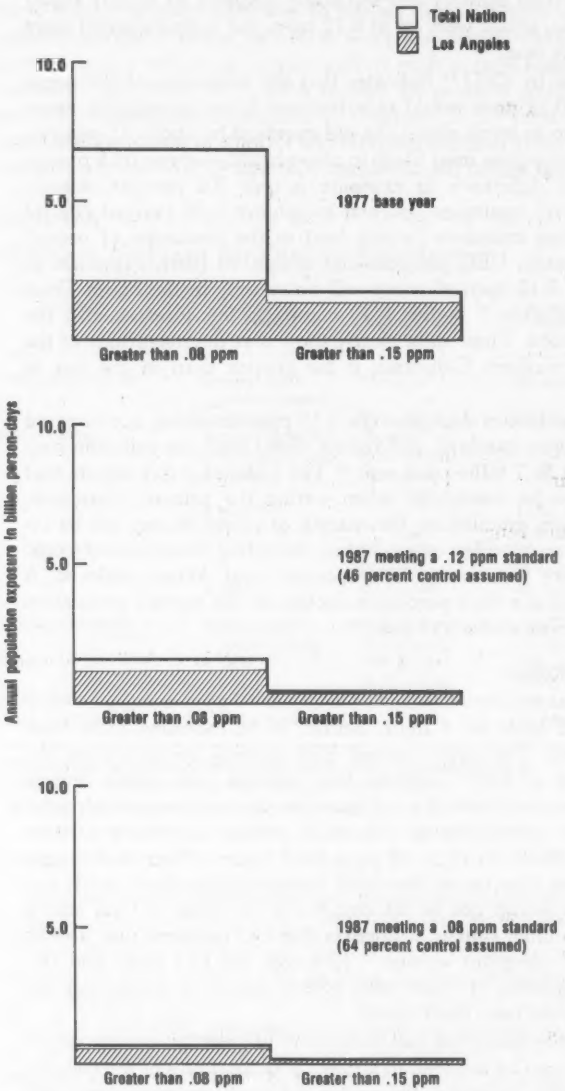
Carbon Monoxide

The current ambient standards for CO are 9 ppm averaged over 8 hours and 35 ppm for 1 hour, neither to be exceeded more than once per year. The draft revised EPA criteria document on the health effects of CO[21] suggests that persons with stable angina (the most common form of cardiovascular disease) are probably the most sensitive population at risk. Such persons may show adverse effects to exposure to 15 to 18 ppm for 8 hours. Other studies suggest that there may be no threshold concentration where stable angina patients would not be affected.[22] On the basis of fetal effects observed in animal studies, it appears that CO exposure may also be of concern to pregnant women.[23] However, the CO levels and frequency of exposure at which such effects would be considered significant have not been determined.

The CEQ has estimated that the current ambient air quality standard of 9 ppm can be attained in almost all urban areas of the country in the mid 1980s, as long as future "on the road" emissions from cars do not exceed about 15 grams per mile (gpm) on the average.[24] However, the current average is about 68 gpm for light duty vehicles. It

Figure 1–13

Present and Future Ozone Exposures for the Nation and the L.A. Basin Under the New and Former Standards



Source: Based on U.S. Environmental Protection Agency data.

cannot be assumed that a 15 gpm average emissions level will be achieved through introduction of catalyst-equipped cars alone. Optimal regulatory strategies that consider deterioration, tampering, and other problems must be developed to assure that the average car does not emit more than 15 gpm. The statutory limit is 3.4 gpm for model year 1981 unless EPA grants a waiver to 7 gpm, which it can do under the Clean Air Act.

Nitrogen Dioxide

The present primary standard for NO_2 limits annual average exposures to the pollutant to 100 $\mu g/m^3$. However, the 1977 Clean Air Act amendments require that EPA also set a short-term NO_2 standard if the data indicate adverse health effects from short periods—3 hours or less of actual exposure.[25] Studies of population exposure to both indoor and outdoor NO_2 suggest increased incidences of acute respiratory illness in situations where exposures to short-term peak NO_2 levels were in the range of 750 to 940 $\mu g/m^3$.[26]

As with ozone, the area of the country that suffers most from NO_2 exposure is the South Coast Basin of California. As Table 1–4 shows, many more person-days of exposure occur in and near Los Angeles than elsewhere in the nation. Relatively severe short-term exposures also occur most often in the Los Angeles area. As Table 1–5 shows, only 10 counties had NO_2 levels above 500 $\mu g/m^3$ for more than 1 day during 1977. Of these only Los Angeles County had more than 10 days in this range. It had 72 days of elevated NO_2 levels.

Table 1–4

Relative Short-Term Nitrogen Dioxide Population Exposure: the Los Angeles Basin Versus the Nation, 1977

(person-days of exposure to various concentrations, in millions)

	300 $\mu g/m^3$	400 $\mu g/m^3$	500 $\mu g/m^3$	600 $\mu g/m^3$	700 $\mu g/m^3$
Nation's Total [a]	1827	936	535	368	171
Los Angeles [b]	1388	844	511	357	167
Los Angeles as % of Total	76%	90%	96%	97%	98%

[a] National data excludes Cuyahoga County.
[b] Los Angeles data include Los Angeles, Orange, San Bernardino, Riverside, and San Diego Counties.

Source: CEQ County-Level Population Model.

Total Suspended Particulates and Sulfur Dioxide

Previous CEQ annual reports have discussed in detail the uncertainties surrounding the health impacts of particulate matter and sulfur oxides.[27] EPA is currently reviewing the effects of SO_2 emission byproducts, that is, of various sulfate compounds in the form of

Table 1–5

Counties Which Had Short-Term Nitrogen Dioxide Levels Greater Than 500 $\mu g/m^3$ for More Than 1 Day in 1977

Region	County	State	Days above 500 $\mu g/m^3$
I	—	—	—
II	—	—	—
III	Washington	D.C.	2
IV	—	—	—
V	Hamilton	Ohio	2
VI	Travis	Texas	2
VII	Denver	Colo.	2
VIII	—	—	—
IX	Los Angeles	Calif.	72
	Orange	Calif.	3
	San Bernadino	Calif.	2
	Riverside	Calif.	4
	San Diego	Calif.	8
	San Joaquin	Calif.	2
X	—	—	—

Source: U.S. Environmental Protection Agency, SAROAD Data System.

fine particulates. Epidemiological and experimental studies have identified those sulfur compounds that are of concern.[28] Physiological studies have indicated that particles up to 15 microns in size can become lodged in the lung (inhalable particles). Fine particles (less than 2.5 microns) penetrate most deeply into the lung. A major question still to be answered is at what levels and composition the total inhalable fine particulates are actually present in the atmosphere of urban regions. A 100-station monitoring network has been established to collect the necessary data. The sites are shown in Table 1–6.

NEW SOURCE PERFORMANCE STANDARDS

EPA's revision of emission standards for new coal-fired steam electric generating plants, a task mandated by the 1977 Clean Air Act amendments,[29] has also engendered controversy. The regulations were proposed in response to Congress' expressed displeasure with the practice of some utilities of meeting existing standards by burning untreated low-sulfur western coals instead of installing control equipment. It is expected that approximately 300 new fossil-fuel-fired power boilers will begin operation in the next 10 years.[30] The proposed standard will cover new plants beginning in late 1983 or early 1984. EPA estimated that had the old standard remained in effect, the new boilers might have been responsible for increasing total national SO_2 emissions by 16 percent between 1975 and 1990.[31]

Initially, in proposed regulations issued in September 1978, EPA proposed to direct all new plants to remove 85 percent (24-hour average) of their potential emissions of SO_2, regardless of the sulfur

Table 1–6

Sites Selected for Particulate Monitoring Network

Location	Site Classification				Total
	Industrial	Commercial	Residential	Rural/ Nonurban	
Philadelphia	2	4	2	2	10
Akron	0	0	1	1	[a]2
Cleveland	2	1	0	0	[a]3
Los Angeles	1	1	1	1	4
Durham	0	1	0	0	1
RTP	0	0	0	1	1
Birmingham	2	1	1	1	5
Phoenix	0	2	3	1	[a]6
Buffalo	2	1	0	1	4
Denver	1	1	3	1	[a]6
New York City	0	2	1	1	4
Chicago	1	1	1	1	4
Houston	1	1	0	1	3
Pittsburgh	1	1	0	1	3
St. Louis	1	0	1	0	2
Baltimore	0	1	1	0	2
NFOS-Kisatchie, La.[b]	0	0	0	1	1
NFOS-Green Mountain, Vt.[b]	0	0	0	1	1
NFOS-Custer, Mont.[b]	0	0	0	1	1
Washington, D.C.	0	1	0	1	2
Detroit	1	1	0	0	2
Kansas City	0	2	0	0	2
Salt Lake City	0	2	0	0	2
San Jose	0	1	1	0	2
Dallas	0	1	1	0	2
Portland	0	1	0	1	2
Seattle	1	1	0	0	2
Oakland	1	1	0	0	2
Five Points, Calif.[c]	0	0	0	1	1
Winnemucca, Nev.[c]	0	0	0	1	1
Boston	0	1	1	0	2
Minneapolis	0	1	1	0	2
Atlanta	1	1	0	0	2
Cincinnati	0	1	0	0	1
Trenton	0	0	0	1	1
Hartford	0	1	0	1	2
El Paso	0	1	0	1	2
Honolulu	0	1	0	0	1
Totals	17	37	19	23	96

[a] One of the sites in Cleveland, two in Akron, and three in Phoenix and Denver are associated with on-going health studies.

[b] NFOS—National Forest Ozone Study.

[c] Rural/Nonurban locations that exceed the total suspended particulate standard but are not industrial.

Source: U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Research Triangle Park, N.C.

content of the coal they would burn.[32] In addition, EPA also proposed a ceiling of 1.2 pounds on the average annual amount of SO_2 that could be emitted per million British thermal units (Btu) of heat input.[33]

Industry spokespeople and others expressed opposition to across-the-board full scrubbing, arguing that the amount of scrubbing should

depend on the sulfur content of the coal used in the utilities' boilers. This would yield a considerable savings in costs, albeit at the expense of increased sulfur dioxide emissions.

On the basis of these and the many other comments received on the proposed standards, EPA announced final regulations on May 25, 1979 that replaced the full-scrubbing approach with a variable one. The final new source standard calls for 70 percent to 90 percent removal (monthly average) of the sulfur dioxide depending on the sulfur content of the coal.[34] EPA also maintained the emissions maximum limit of 1.2 pounds per million Btu heat input but changed the averaging time from 24 hours to monthly.[35] Although less stringent than the proposed standards, the final regulations are stricter than the old standards they replaced.

One positive effect of the 70 to 90 percent standard may be development of effective "dry scrubbing" of stack gases to remove sulfur dioxide. Dry scrubbing is not a new concept for removing sulfur dioxide from power plant stacks. The technique, involving the injection of pulverized limestone along with the coal into the boiler was tested approximately 10 years ago. However, this direct injection into the boiler only removed 30 to 50 percent of the sulfur dioxide and required large amounts of limestone because its effectiveness was reduced by high boiler temperatures.[36]

The present approach involves two different methods of bringing the SO_2-laden flue gas into contact with the dry limestone (calcium carbonate) or nahcolite (sodium bicarbonate). One approach is to coat a baghouse filter with the powdered sodium bicarbonate so that it removes the SO_2 as the flue gas passes through. The other method is to spray a slurry of calcium carbonate into the gas stream, and then collect the resulting sulfur-containing material on a baghouse filter. Spray drying is a "state-of-the-art" technology that has been applied to numerous industrial processes. The current interest in using dry scrubbing evolved from the examination of alternatives to using wet limestone scrubbers on plants in the arid West, where water supplies are limited. Nahcolite is readily available in the western states, in particular in the oil-shale regions; this reduces shipping costs of limestone. The sulfur dioxide removal efficiencies eventually may well approach the 90 percent levels achieved by wet scrubbing.[37]

NATIONAL EMISSION STANDARDS FOR HAZARDOUS AIR POLLUTANTS

Section 112 of the Clean Air Act requires EPA to establish national emission standards for hazardous air pollutants.[38] A hazardous air pollutant is one to which no ambient air quality standard applies and that, in the judgment of the EPA Administrator, may reasonably be anticipated to result in an increase in mortality or in serious, irreversible, or incapacitating reversible illness. Pollutants in this category are usually emitted by very specific industrial sources.

In 1971, EPA listed asbestos, beryllium, and mercury as hazardous pollutants and promulgated standards in 1973 to limit emissions of these pollutants.[39] Since then, vinyl chloride has been listed as hazardous, and standards limiting emissions from manufacture of vinyl chloride and polyvinyl chloride have been promulgated.[40] In 1977, benzene was added to the list of hazardous pollutants.[41]

In 1978, programs to identify and assess the effects of potentially hazardous pollutants were expanded to include development of an airborne carcinogen policy that would set forth EPA's plans for identifying, assessing, and regulating such substances.[42] A number of synthetic organic chemicals were studied. Health risk assessments for arsenic and for coke-oven emissions were made preparatory to including them on the "hazardous" list.

Health-risk assessment pertaining to asbestiform minerals (minerals resembling asbestos, a confirmed carcinogen) was initiated to provide information needed to support decisions on the regulation of emissions from taconite mining and processing and use of crushed stone.

STATE IMPLEMENTATION PLANS

The 1970 Clean Air Act amendments directed EPA to set ambient air quality standards and to establish emission limitations for new pollutant sources—such as new factories, autos, and trucks.[43] However, the task of developing strategies for attaining the ambient air quality standards was given to the states. States must therefore have State Implementation Plans (SIPs) that spell out in specific detail how federal goals will be met.

Most SIPs are currently in the process of being revised. The 1977 Clean Air Act amendments established deadlines later than those in the original 1970 legislation for attaining ambient air standards.[44] The target date for complying with the standards for total suspended particulates, sulfur dioxide, and nitrogen dioxide is now 1982; it can be as late as 1987 for ozone and carbon monoxide, the automobile-related pollutants. The cut-off date by which states should have developed revised SIPs for meeting these goals was July 1, 1979.

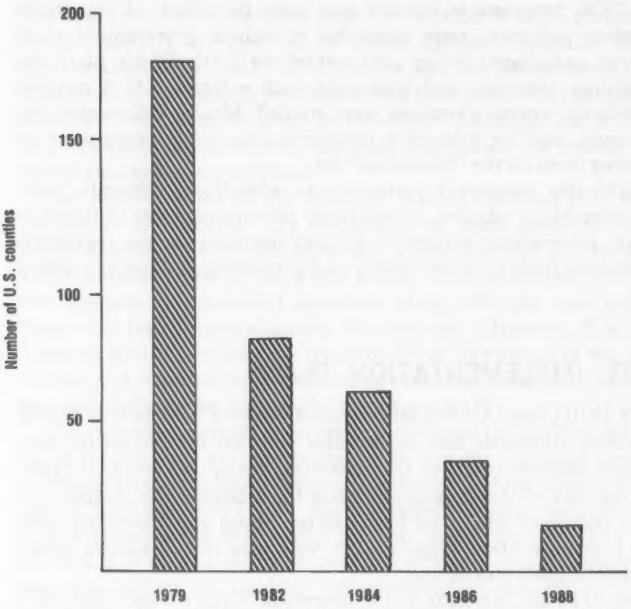
Although most states (44) submitted their plans by late July, only one state, Wyoming, had an approved plan in place by the July 1979 deadline. Fifteen more had been proposed for approval by EPA and were out for public comment by July 1.[45] Legislation has been introduced that would give EPA and states another year for this process, and would delay deadlines for meeting ambient air standards by another year as well. However, EPA expressed confidence that most plans would be approved by the fall. The agency did not foresee imposing congressionally authorized sanctions against noncomplying states, such as a cut-off of highway funds.[46]

One of the problems in developing state plans is that of finding appropriate strategies for controlling automobile-related pollutants

Figure 1–14

U.S. Counties, by Year, in Nonattainment of .12 ppm Ozone Standard With 40 Percent Emissions Control

(Los Angeles basin excluded)



Source: Based on U.S. Environmental Protection Agency data.

in parts of the country where the gradual replacement of old cars by new cars equipped with catalytic converters will not suffice to bring pollution down to acceptable levels. CEQ has calculated that if all counties were to achieve a 40-percent reduction through any combination of controls during the next decade, then the number of counties (excluding those in the Los Angeles Basin) in nonattainment for ozone would decline from 184 in 1979 to 85 in 1982 (see Figure 1–14). This projection is based on the assumption that most counties will be able to achieve a 40-percent reduction in ozone levels simply through the gradual introduction of autos and trucks equipped with emission controls.[47] By 1988, 16 counties outside of Los Angeles would still require more stringent and complex control strategies. More comprehensive SIPs containing a mix of stricter retrofit programs for stationary sources, transportation control plans, and automobile inspection and maintenance programs should thus prove necessary for these 16 counties and the Los Angeles Basin.

INSPECTION AND MAINTENANCE

Obviously, automobile emission controls will make the greatest contribution to meeting ozone and carbon monoxide standards throughout the country. However, vehicle emission control systems must not only be in place; they must be performing at an acceptable level. A problem for regulators is that current systems are often found to be malfunctioning because of poor auto maintenance or owner tampering.[48] The Congress has therefore mandated that auto inspection and maintenance programs be instituted in all regions of the country where an extension of the ozone standard attainment date from 1982 to 1987 will be required.

Some deterioration of auto emission-control systems is bound to occur. The regulatory problem is to keep the average deterioration within acceptable limits from an air quality point of view. Inspection and maintenance programs should be tailored to the cause of the problem. For example, if an unacceptable percentage of car owners tamper with their control systems, a roadside spot-check program may be the most appropriate strategy. However, if most owners are simply failing to maintain the devices, an annual inspection and maintenance program for all may be a better choice.

Inspection and maintenance programs have become a highly controversial aspect of national air pollution control programs, however. In June 1979, for example, the New York state legislature had refused to enact an inspection and maintenance program, although Governor Carey had proposed a program of annual auto testing. Legislators have objected both on the grounds of cost, and because the program would impose too great a burden on the average driver.

TRANSPORTATION CONTROL MEASURES

Regulators in many cases are also seeking to reduce automobile-related pollution by cutting down on use of automobiles in high-pollution areas. The 1977 Clean Air Act amendments required EPA and the Department of Transportation (DOT) to better coordinate their efforts in this regard,[49] so that one agency would not be encouraging vehicular travel while the other discouraged it. In June 1978, EPA and DOT signed a memorandum of understanding regarding the integration of transportation and air quality planning and jointly issued "Transportation—Air Quality Planning Guidelines" that federal, state, and local air quality and transportation agencies, as well as regional planning agencies, are to use in devising transportation plans.[50] Then in December of 1978, the two agencies jointly announced the availability of urban air quality planning grants and set forth policies and procedures for applying for funds.[51]

Under the 1977 amendments, the Administrator of EPA and the Secretary of DOT were not to approve projects or award any grants if a state has not submitted a SIP by July 1, 1979, or is not making a good faith effort to submit one. In June 1979, EPA and DOT

published proposed policy and procedure for applying these funding limitations.[52]

The EPA Administrator may also withhold, condition, or restrict sewage treatment works grants if a state does not have an approved SIP in effect. An interim draft policy was proposed in this regard in July 1979.[53] State and local officials were given an opportunity to review the draft policy.

Both of these restraining policies only apply to regions where (1) attainment of the NAAQS will not be achieved by 1982; (2) transportation control plans are necessary to achieve the standard; and (3) an approvable SIP was not submitted by the statutory date.

THE BUBBLE CONCEPT

State implementation plans establish emission limits for stationary, as well as mobile, sources of air pollution. These limits are calculated to assure that federal air quality standards are attained in that location. In making these decisions, states regularly take into account the nature and amount of emissions from each source, the control technology available, and the time required for its installation. However, SIPs are not necessarily as economically efficient as possible, nor are regulated companies prompted to seek innovations in control technology.

For this reason, EPA proposed on January 18, 1979 that states allow plants to reduce controls in that portion of a facility in which costs are high, in exchange for an equal increase in control in a part of the same facility where abatement is less expensive.[54] Because it treats a facility in terms of its total emissions—as if it had a bubble over it—this has been called "the bubble concept." The policy statement recommends that the states inform facilities of the availability of the alternative emission-reduction approach, explain the advantages and conditions of use, and be receptive to proposals from facilities seeking to employ the more cost-effective mix of controls this policy allows. Under the proposed policy, facilities may obtain financial savings by employing more cost-effective mixes of control techniques than current process-by-process regulations allow, as long as total environmental benefits are not reduced.

Further discussion of the bubble concept appears in Chapter 12.

SPECIAL AIR POLLUTION PROBLEMS

AUTO EMISSIONS: INNOVATIVE APPROACHES TO CONTROL

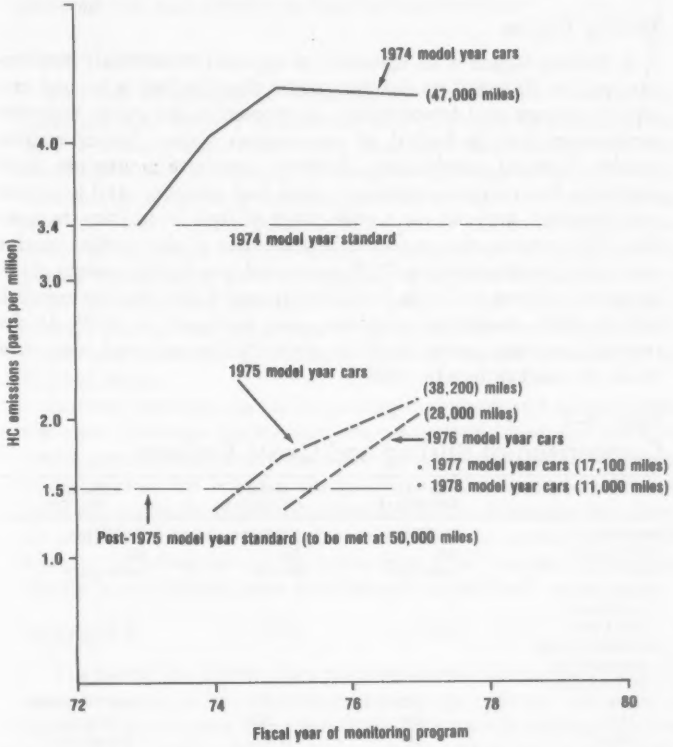
Catalytic converters are currently the primary method of controlling auto emissions. Catalytic converters have been installed on most U.S.-produced cars since 1975. However, many smaller European and Japanese imports have been able to meet emission standards using stratified-charge combustion and electronic-fuel-injection techniques.

The overall reliability of the nation's pool of catalyst-equipped cars has varied among carmakers as well as geographically. EPA field tests have demonstrated significant deterioration in average emissions as mileage accrues (see Figure 1–15). To date, this deterioration has been taking place with newer model cars as well as old. The deterioration found in the tests has been mainly due to poor vehicle maintenance and tampering with the carburetor. The use of leaded gasoline in some catalyst-equipped cars may also be reducing the overall effectiveness of controls on the car fleet. Although there has been much speculation about fuel switching, the extent to which it is really happening has yet to be determined with any reliability.

The question thus arises as to whether there are more reliable and cheaper alternatives to the current systems. Widespread conversion

Figure 1–15

Trends in Average Hydrocarbon Emissions, by Model Year of Cars, 1973–77



Source: U.S. Environmental Protection Agency, Office of Mobile Source Air Pollution Control.

to diesel engines shows the greatest short-term promise; however, several health-related issues must be examined. Diesels without external control systems can readily meet the 1980 hydrocarbon and carbon monoxide standard. Nitrogen oxide emissions may prove to be a problem if it becomes necessary to impose a less than 1.0 gpm standard to meet air quality needs. The major potential air pollution problem associated with diesels relates to their emission of carcinogenic carbon compounds. Studies are underway to determine the significance of such emissions.[55] A switch to diesel engines in cars could bring other benefits as well: better fuel mileage; low evaporation losses of fuel, which contribute to ozone formation; and lower risk of fire in auto accidents.[56]

Other alternatives are being intensively studied by the Department of Energy (DOE). The most promising involve electric, hybrid electric, Stirling, and gas turbine-powered vehicles. Approximately $90 million is earmarked in the fiscal year 1979 budget for this program.[57] A brief description of each power system and its development status follows.

Stirling Engine

A Stirling engine is an external (as opposed to internal) combustion engine. External combustion means that the fuel is burned at a steady pressure and temperature, as opposed to the cyclic explosive combustion that is typical of car engines today. Steam engines employ external combustion. External combustion engines have extremely low pollution emissions, good fuel economy, and low noise and vibration, and can use a wide range of fuels in addition to gasoline. The present and expected performance of the Stirling engine car under development by DOE compared to a similar weight diesel compact is shown in Table 1–7. The Genesis 1 car, the first research vehicle built under the program, was produced in 1979. If the research program meets all of its goals, Stirling-powered cars could reach the marketplace by 1988.

Table 1–7
Comparison of Stirling and Diesel Engines

Measurement	Stirling Genesis–1	Diesel Vehicle	Advanced Stirling
Test Weight	3376 lbs	3418 lbs	3100 lbs
Horsepower	45	60	86
Fuel	Gasoline	Diesel	Wide-cut *
Mileage-MPG			
Combined			
CVS Cycle	19.4	24.8	44.2
Emissions (Avg)			
Grams/Mile			
Urban Cycle			
CO	.43	1.6	Approximately
HC	.12	.32	same as
NO_x	.37	1.48	Genesis–1

* Wide-cut is diesel-like fuel derived from petroleum or synthetic fuel.
Source: Mechanical Technology Inc., Latham, N.Y.

Gas Turbines

Gas turbine-powered cars have been under development for many years, most notably by Chrysler, which built experimental cars in the early sixties. Gas turbines are also external combustion engines. Chrysler never began production because of high costs and some drivability problems. However, gas turbine engines are currently used by the long-haul trucking industry.

The two main research problems associated with the development of auto turbine engines are fuel economy and nitrogen oxide emissions.[58] In order to get better fuel economy, the turbines must operate at high temperatures. These temperatures require special ceramic engine parts. A second problem, nitrogen oxide emissions, could be controlled with minor engine design changes according to some experts, unless the emission standard becomes stricter than 1 gpm. (It is now 1.5 gpm). It is expected that the practicality of these advanced turbine engines will not be known until 1984. At that time, DOE will make a decision about the long-term suitability of turbine-powered cars, and whether to fund further research.[59]

Electric Vehicles

The two advantages of rechargeable, battery-driven electric cars and light-duty delivery vehicles are that they emit no pollutants and save petroleum-based fuels. Their near-term disadvantages are their small size, which is necessary to conserve the small amount of power that can be stored in a battery, and relative cost. It is not expected that use would require building more power plants because the cars would be recharged at night during off-peak hours, although existing power plants might have to consume more fossil or nuclear fuel to meet the additional demand. DOE projects that up to 30 million electric vehicles may be in use by the year 2005 (see Figure 1–16). There are currently 130 million privately owned vehicles in the United States.

Current research aims at improving the power and range of electric cars. Prototype electric cars use conventional lead acid batteries, which are relatively heavy, have low power output and have a range of 50 miles or less between charges.[60] Several advanced battery systems are under development; some are in the demonstration phase. In addition, extensive research is being done to improve propulsion systems, including developing better motors and brakes, regenerative flywheels, and lighter, more aerodynamic car bodies.[61]

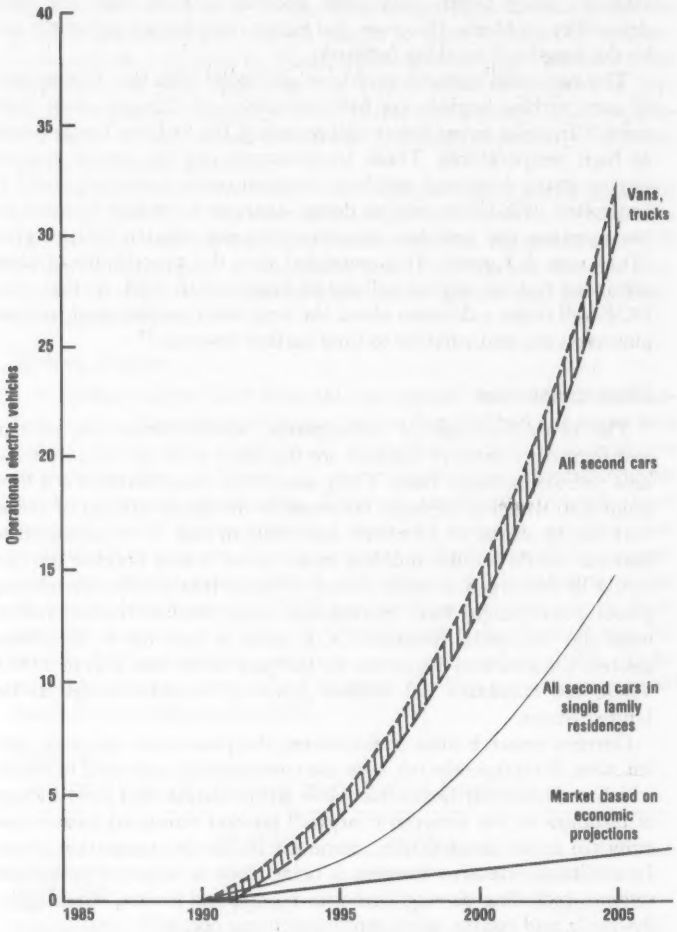
Hybrids

The hybrid car differs from the pure electric car in that it includes a conventional motor capable of driving the car and recharging its battery. The car must thus carry fuel to drive a conventional combustion engine, which will emit some pollution. However, in high-pollution areas such as congested urban traffic, it could run solely on batteries.

Figure 1–16

DOE Projections of Electric Vehicle Markets

(in millions)



Source: U.S. Department of Energy, Environmental Development Plan for Transportation Energy Conservation, March 1978.

Hybrids have the same markets as completely electric cars. Hybrids offer some possible additional benefits, including longer range and better acceleration. There are a multitude of hybrid power system configurations that have yet to be fully explored. Current research is at the "proof-of-the-concept" stage rather than at the prototype-

demonstration stage, as are the other advanced systems described above.[62]

NEW AUTOMOBILE FUELS

The mid-1979 gasoline crisis has led to new interest in Congress and among policymakers in finding substitutes for petroleum-based fuels. The air pollution problems associated with manufacturing synthetic fuels are significant, and are discussed in the energy chapter of this report. Their potential impact on auto emissions is also important, and is discussed below.

Synthetic Petroleum Fuels

Synthetic petroleum fuels (syn fuels) are derived from oil shale and coal. Such fuels would be suitable for all of the advanced combustion engines previously discussed, as well as for conventional cars. The vehicle pollution emissions control problems with respect to hydrocarbons, carbon monoxide, and nitrogen oxides would not differ much from those associated with use of petroleum-based fuels. Problems associated with potentially higher emissions of polycyclic organics, which are carcinogenic, have yet to be assessed.

Alcohol Fuels

Many strategies have been proposed to introduce alcohol (methanol and ethanol) into the automotive fuel market. The most immediate and practical approach involves the use of an alcohol/gasoline mixture (Gasahol, methanol and gasoline; or Gasohol, ethanol and gasoline) in conventional gasoline engines. Such blending is a step toward possible full substitution of alcohol. Most cars on the road can use blends containing 5 to 10 percent alcohol without engine modification or drivability problems.[63] Most alcohol currently is produced either from petrochemical feedstocks—natural gas and ethylene—or from plant material and used to make competitive products, such as beverage ethanol. Methanol can be made from coal. Methanol can also be produced as a secondary form of solar energy through the biodegradation of organic byproducts (biomass), such as crop residues and solid wastes. Ethanol is made by fermenting grain. This source obviously has a competing market that is miniscule compared to the volume demanded of the transportation sector. Although no biomass fuel resources (methanol) could hope to provide more than 1 to 2 percent of the nation's projected energy demand, fermentation ethanol from new production sources might make significant local contributions to transportation fuels.[64] Because of the relatively small proportion of alcohol in gasohol, the air pollution aspects of such conversions are no different than those associated with gasoline use.

The use of pure alcohol (neat alcohol) as a fuel would require considerable modification of existing gasoline engines, but would be readily adaptable to the advanced external combustion engines.

Problems regarding both poor starting at temperatures below 50° F (10° C) and corrosion are being investigated.[65] Because of the lower energy content of alcohol on a volumetric basis, larger on-board fuel systems would be required. This problem would also extend itself into the entire fuel transportation and handling scheme, although its impact would depend on the degree of conversion. Although hydrocarbon, carbon monoxide, and nitrogen dioxide emissions are comparably lower for alcohol relative to gasoline, potential problems regarding currently unregulated aldehyde emissions must be evaluated.

Hydrogen

Hydrogen has been identified as a long-term alternative to petroleum in transportation fuels. Hydrogen is more properly considered an energy carrier than a fuel because it is made by using electricity to break down water into hydrogen and oxygen. Its practicality as a fuel is not assured, because generating significant quantities of hydrogen requires an abundant source of cheap electrical energy. Very advanced techniques for using solar energy or other "renewable energy sources" for hydrogen production are long-term possibilities.

Numerous technical problems attend the use of hydrogen in conventional internal combustion engines because hydrogen and gasoline have critically different physical and chemical properties. The most critical of the operational problems arising from the use of hydrogen in an unmodified engine are combustion problems and high nitrogen dioxide emissions due to the rapid, high-temperature combustion.[66] Another operational problem is that of storing sufficient hydrogen on-board to give the vehicle a useful driving range. However, hydrocarbon and carbon monoxide emissions are nonexistent, except for small emissions caused by the burning of lubricating oil.

ACID RAIN

Acid rain is recognized as one of the two most serious global environmental problems associated with fossil fuel combustion, the other being the accumulation of carbon dioxide in the atmosphere. Insufficient knowledge exists about the explicit causes and total effects of acid rain, a fact that has hampered development of sound control and mitigation measures.

Acid rain is a major environmental problem on both sides of the Atlantic Ocean. Although the problem is currently confined to the Northern Hemisphere, it appears likely that the problem will also occur in the Southern Hemisphere.[67] It is considered a primary environmental threat in the Scandinavian countries and a source of marked concern in Japan and Canada. As required by the National Energy Plan in 1977, the President commissioned a study on

potential environmental impacts of increased coal use. The study report, known as the Rall Report,[68] identified acid rain in the United States as one of the six environmental problems requiring closer scrutiny.

The acidity of rainfall is increased so that it falls below the normal pH of 5.7 by the presence of acid sulfates and nitrates. Although sulfur and nitrogen are present in abundant amounts in the natural biogenic cycles of the earth, the acid-rain problems have been induced by man's activity. Power plants, smelters, other industry, home heating, and automobiles produce varying quantities of sulfur and nitrogen oxides. Although acid rain may have some unquantified benefits, the adverse effects of acid rain are of great concern. In the eastern half of the United States, the average pH of rainfall is now between 4.0 and 4.5.[69] Some rainfall has a pH as low as 3.0. This is about equivalent to the acidity of lemon juice. In the eastern half of the United States, the acidity of rainfall appears to have increased about 50-fold during the past 25 years.

The research effort to date for assessing the acid-rain problem has been small in comparison to what is needed. Few concrete facts are known. In Scandinavia, in Canada, and in the northeastern half of the United States, many lakes and estuaries have experienced depletions of fish life and, in some cases, have become totally devoid of fish.[70] Such losses are an indication of major changes in ecological balances that may be more far reaching than the loss of a recreational resource. Sweden alone has placed the economic loss to its recreational and commercial fishing industry at $50 to $100 million in 1973.[71] Other effects have not been quantified. Loss of crop productivity and forest yields due to acid rain may be prevalent. Acid rain also damages steel and stone structures, as well as works of art. Many of these effects may be permanent.

The trace metal levels in drinking water supplies may be increased to harmful levels due to the long-term leaching effect of acid rain. Trace metals, pesticides, and other organic compounds may be transported great distances and deposited.

Several governmental agencies including the Departments of Agriculture, Interior, Energy, Commerce, the Environmental Protection Agency, the National Science Foundation, and the Council on Environmental Quality, have planned or have underway research efforts related to the acid-rain problem. Some states have also undertaken research efforts. Industry, in particular the electric power industry, is also sponsoring research on the causes and effects of acid rain. The Governments of Canada and the United States have begun cooperation on the issue. However, coordination and cooperation among these agencies and organizations need to be improved. In addition, a preliminary research planning study by CEQ [72] indicates that efforts need to be more comprehensive in nature and need increased resources.

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CHAPTER 2

WATER QUALITY

National efforts during the decade to improve surface water quality continue to show positive results. There is evidence of improvement in many specific places, largely due to better control of pollution from industry and wastewater treatment plants. However, the nation is still a great distance from the goal of restoring and maintaining "the chemical, physical, and biological integrity of the Nation's waters." [1] Few areas are completely free of water quality problems. Although many industrial point source discharges of conventional pollution are coming under control, nonpoint and municipal sources remain major problems. Toxic pollutants in surface waters and contamination of ground water by conventional pollutants and toxic substances are serious problems that nation is just beginning to understand and control. Toxic materials can negate much of the progress made in controlling traditional or sanitary pollutants; for example, salmon now returning to the Hudson River estuary after a 75-year absence cannot be eaten due to high PCB (polychlorinated biphenyls) contamination.

The first section of this chapter, "Conditions and Trends," discusses the quality of the nation's waters, including rivers, lakes, and ground waters. The second section, "Actions and Programs," covers laws and efforts designed to improve water quality. It also includes a discussion of the major progress in industrial pollution abatement and the lesser progress in municipal sewage treatment, control of nonpoint sources of pollution, and protection of drinking water quality.

CONDITIONS AND TRENDS

SURFACE WATERS

Problems with water quality data collection and assessment are still numerous. But the available evidence, based on analysis of U.S. Geological Survey (USGS) data, suggests that water quality in the United States, while not showing vast improvement since the early 1970s, is at least not getting worse. The data indicate that water pollution from some conventional and toxic pollutants is still widespread. Although reductions have occurred at certain of the USGS monitor-

ing locations, levels of some of the key pollutants analyzed have remained approximately constant over the past 4 years. The primary reason is the impact of urban and agricultural runoff and other "nonpoint" sources of pollution of water quality, a problem the nation has just begun to tackle. Another important factor is the impact of municipal sewage wastes, which are still years away from being totally controlled. The fact that our surface waters have not deteriorated further, however, in a period of rising population and Gross National Product (GNP), is a victory for the nation's water pollution control efforts and is in no small part due to industrial cleanup of conventional pollutants.

National Overview

Industrial and municipal discharges—and in some places combined sewer overflows as well—affect water quality in most parts of the United States (see Figures 2–1, 2–2, and 2–3). EPA's 1977 Water Quality Report to the Congress [2] shows that all but a very few of the 246 water basins in the United States are affected, in whole or in part, by some kind of pollution. These maps, based on field data collected by the states in 1975 and 1976, somewhat overstate the exent of water pollution in the United States because only part of a basin may be affected. Nevertheless, they present the best available current overview of the extent of pollution from these sources.

Hundreds of chemical substances have been identified as contributors to water pollution. Furthermore, chemical reactions among them are constantly taking place in the water, and our knowledge of these reactions is fragmentary.

Finding suitable indicators of water quality is difficult. Over the years attempts have been made to identify a few variables that summarize water quality succinctly. At present, experts advocate at least 10 categories of indicators. Those most widely employed by federal and state agencies are aggregate indices—e.g., toxic metals, nutrients, sediments, and pesticides.

The measurements chosen here for an assessment of water quality give a partial summary of our current knowledge of water pollution from industrial, municipal, and agricultural sources. They are: fecal coliform bacteria, dissolved oxygen, total phosphorus, total mercury, and total lead.

The technical analyses originating at the Council on Environmental Quality (CEQ) reported in this chapter relied heavily on data supplied by the U.S. Environmental Protection Agency (EPA) and the USGS. These data were critically evaluated using CEQ's User-Prompted Graphic Data Evaluation computer system (UPGRADE). The USGS data are taken from the National Stream Quality Accounting Network (NASQAN). The data are representative of watersheds upstream of the monitoring stations. Many of these watersheds are not heavily affected by human activities. The data are taken at or near the mouths of all major U.S. rivers and their principal tributaries. The 349 stations range from those on

Figure 2–1

Basins Affected by Industrial Discharges, 1977

Source: U.S. Environmental Protection Agency. *National Water Quality Inventory: 1977 Report to Congress* (Washington, D.C.: U.S. Government Printing Office, 1978).

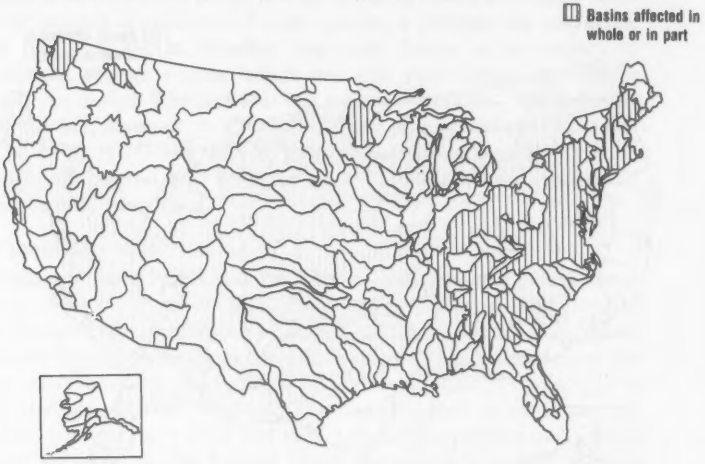
Figure 2–2

Basic Affected by Municipal Discharges, 1977

Source: U.S. Environmental Protection Agency. *National Water Quality Inventory: 1977 Report to Congress* (Washington, D.C.: U.S. Government Printing Office, 1978).

Figure 2–3

Basins Affected by Combined Sewer Overflows, 1977



Source: U.S. Environmental Protection Agency. *National Water Quality Inventory: 1977 Report to Congress* (Washington, D.C.: U.S. Government Printing Office, 1978).

large rivers such as the Mississippi at New Orleans, to ones on small rivers such as the Choptank in Maryland, and on intermittent streams such as the Santa Cruz in Arizona. By their nature, the NASQAN data tend to mask out the best and the worst river waters in most areas.

A CEQ analysis of the USGS data suggests that there has been little or no overall change in the levels of five major water pollution indicators over the 4 water years, 1975 through 1978. CEQ analyzed the data in terms of the percentage of measurements that did not meet the threshold values indicated in Table 2–1. Most, but not all, of the threshold values were chosen at the "criteria levels" set by EPA in their "Redbook," *Quality Criteria for Water*.[3] Some of the pollutants had low violation rates throughout the 4 years.

The results of the analysis at these data are depicted in five sets of maps, Figures 2–4 through 2–8. The maps are shaded to show the percentage of measurements in violation during water years 1975 through 1978. White spaces indicate an absence of data.

Fecal Coliform Bacteria (FC) Fecal coliform bacteria are a traditional sanitary engineering measure of water pollution from the feces of warm-blooded animals. Such pollution usually arises from improperly treated human sewage, street runoff, combined sewer overflows in urban regions, feedlots and grazing lands in agricultural areas, and wildlife.

CEQ has computed violation rates for fecal coliform bacteria as the percentage of all measurements that exceeded the value of 200

Table 2–1

Thresholds Used in CEQ Analysis of National Water Quality

Indicator	Abbreviation	Threshold Level
Fecal Coliform Bacteria	FC	200 cells/100 ml [a]
Dissolved Oxygen	DO	5. mg/l [b]
Total Phosphorus	TP	0.1 mg/l [c]
Total Mercury	Hg	2. μg/l [d]
Total Lead	Pb	50. μg/l [d]
Biochemical Oxygen Demand	BOD_5	5. mg/l [e]

l=liter; ml=milliliter; mg=milligram; μg=microgram.

[a] Criteria level for "bathing waters" from EPA "Redbook."
[b] Criteria level for "good fish populations" from EPA "Redbook."
[c] Value discussed for "prevention of plant nuisances in streams or other flowing waters not discharging directly to lakes or impoundments" in EPA "Redbook."
[d] Criteria level for "domestic water supply (health)" from EPA "Redbook." Criteria level for preservation of aquatic life is much lower.
[e] Value chosen by CEQ.

cells per 100 ml, the criteria level set for bathing waters in EPA's "Redbook." [4] There is no legal uniform national standard for concentrations of fecal coliform bacteria in waters used for swimming; standards vary with water use and local laws, and state standards sometimes differ from nationally recommended criteria.

The violation rates for FC for 1975 through 1978 appear in Figure 2–4. They show some fluctuation over the 4 years, and it does not appear that any great improvement has taken place over this time span. Generally, the areas showing more than 99 percent of measurements in violation do not change in number, except for a drop in 1977. The northeastern areas that show high violation rates do not change significantly over the years. Much of the country has a 50 to 99 percent violation rate with fluctuations taking place in the Southwest. Other areas shift from year to year but remain at a medium to high violation rate.

Dissolved Oxygen (DO) The amount of oxygen dissolved in water is affected by many different water pollutants as well as certain natural processes. It is one measure of the ability of water to support aquatic animal life, but it is only a necessary and not a sufficient condition. Depressed DO levels most often occur in water subject to large amounts of decaying organic matter from natural processes or human disturbances—e.g., sewage effluents—in warm water.

CEQ has computed the violation rates for dissolved oxygen as the percentage of measurements that fell below the value of 5 mg per *l*, the criteria level set for good fish populations in EPA's "Redbook." [5]

As Figure 2–5 illustrates, violation rates for DO were generally low in most areas at the outset of the 4 years, and remained so.

Total Phosphorus (TP) Phosphorus, a nutrient essential to all plant growth, can trigger noxious algal blooms, especially in fresh water. High levels generally occur in water as the result of human

Figure 2–4

Fecal Coliform Bacteria, 1975–78

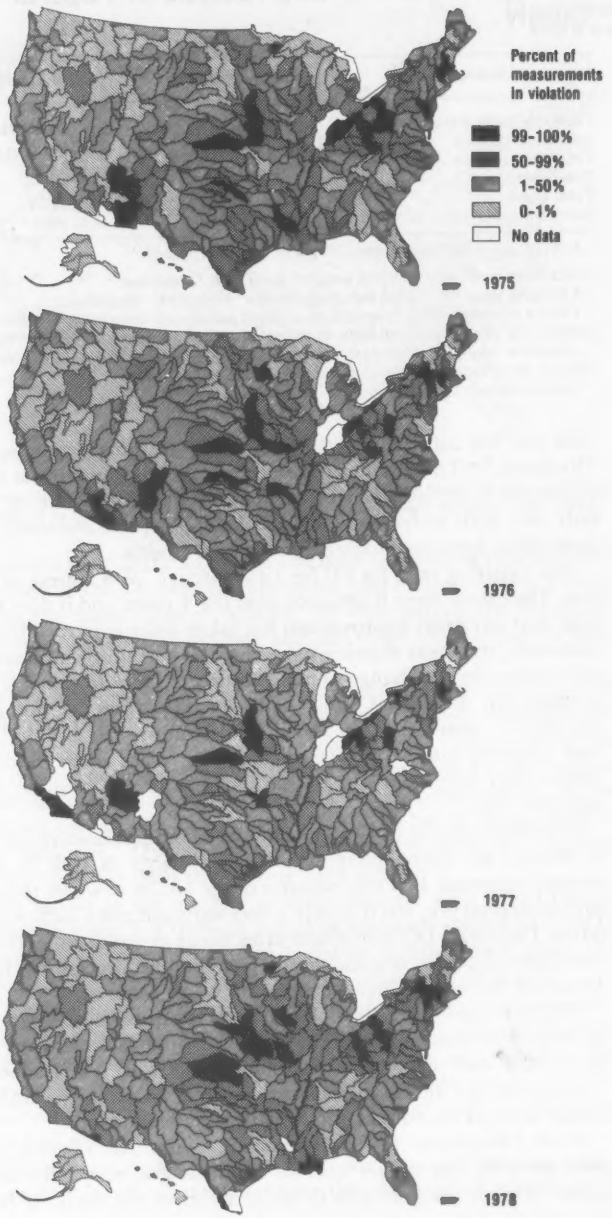


Figure 2–5

Dissolved Oxygen, 1975–78

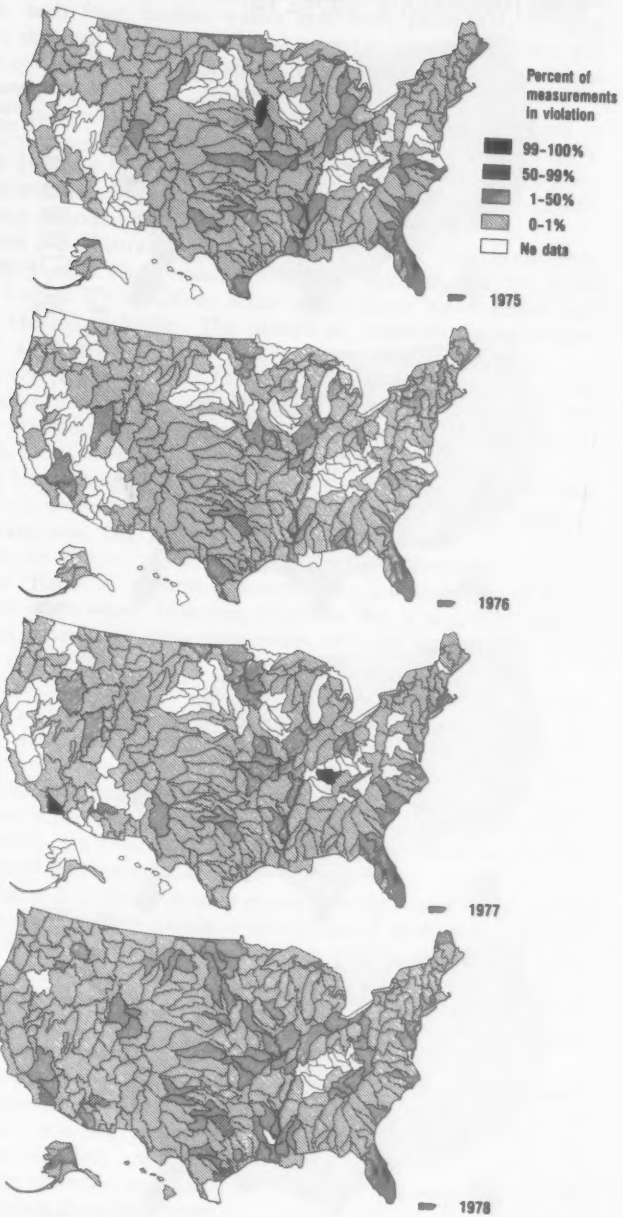
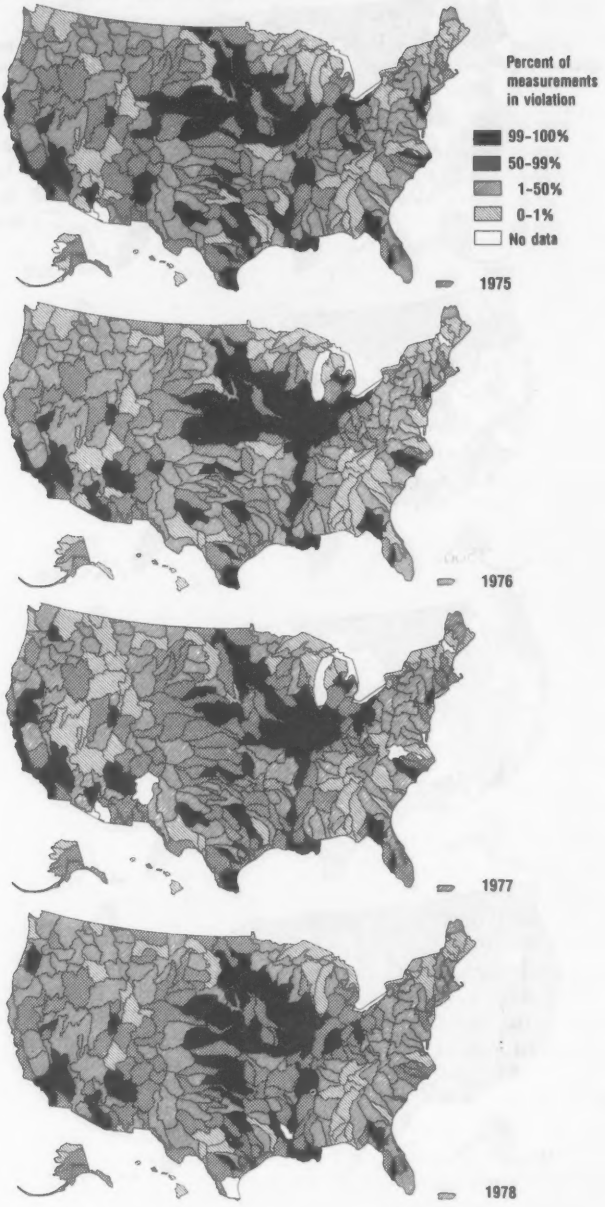


Figure 2–6

Total Phosphorus, 1975–78



activity. In agricultural areas, phosphorus can run off fields when erosion occurs. In urban areas, phosphorus can arise from municipal sewage, both from human wastes and from phosphates in most laundry detergents. Most municipal secondary treatment plants will not remove the bulk of the phosphorus from wastes treated, even when operating properly.

CEQ has computed the violation rates for total phosphorus as the percentage of measurements that exceeded the value of 0.1 mg/*l*, a value discussed in the EPA "Redbook" for the prevention of plant nuisances in streams or other flowing waters not discharging directly to lakes or impoundments.[6]

Figure 2–6 illustrates violation rates for total phosphorus over the same 4 years. High violation rates exist across the country. Most of the highest TP violations occur in the Great Lakes region and Upper Mississippi Valley. The pattern of violations does fluctuate, but few areas show substantial improvement over the years.

Mercury (Hg) and Lead (Pb) These toxic metals are two of the more toxic and ubiquitous of the heavy metals. Neither is very soluble in fresh water, and natural concentrations of each would normally be quite low.

CEQ has computed the violation rates for total mercury and total lead as the percentage of measurements that exceeded the values of 2.0 micrograms (μg)/*l* and 50.0 $\mu g/l$, respectively, the criteria levels set for domestic water supply in the EPA "Redbook." In each case, the "Redbook" criteria concentration for preservation of aquatic life is much lower. However, there are few, if any, field data of sufficient accuracy to allow preparation of maps based on the lower criteria values.[7, 8]

The data in Figures 2–7 and 2–8 show the violation rates for total mercury and total lead, respectively, in natural waters. There are also few data, though, on the chemical forms of these total metals. This lack of speciation data makes it virtually impossible to draw conclusions concerning possible plant and animal toxicities. Bacteria in sediments can convert mercury to an organic form—methyl mercury—which is a toxic nerve poison. Some believe that lead can be transformed in a similar manner.

As Figure 2–7 shows, total mercury violation rates based on the domestic water supply criteria level are mainly in the 0 to 1 percent range. During the 4 years, only one area (Alabama) shows a violation rate in the 99 to 100 percent range for 1 year, 1977, but this is questionable because only one sample was taken during the entire year at that station. The data indicate that no degradation has taken place over the 4 years.

The maps in Figure 2–8 show the total lead violation rates based on the domestic water supply criteria level for the country. In the East, there is a low record of violations over the 4 years. For the West, the violations are high where data are available. The data for 1978 were collected and analyzed using new methods and are the most accurate over the 4 years.

Figure 2–7

Total Mercury, 1975–78

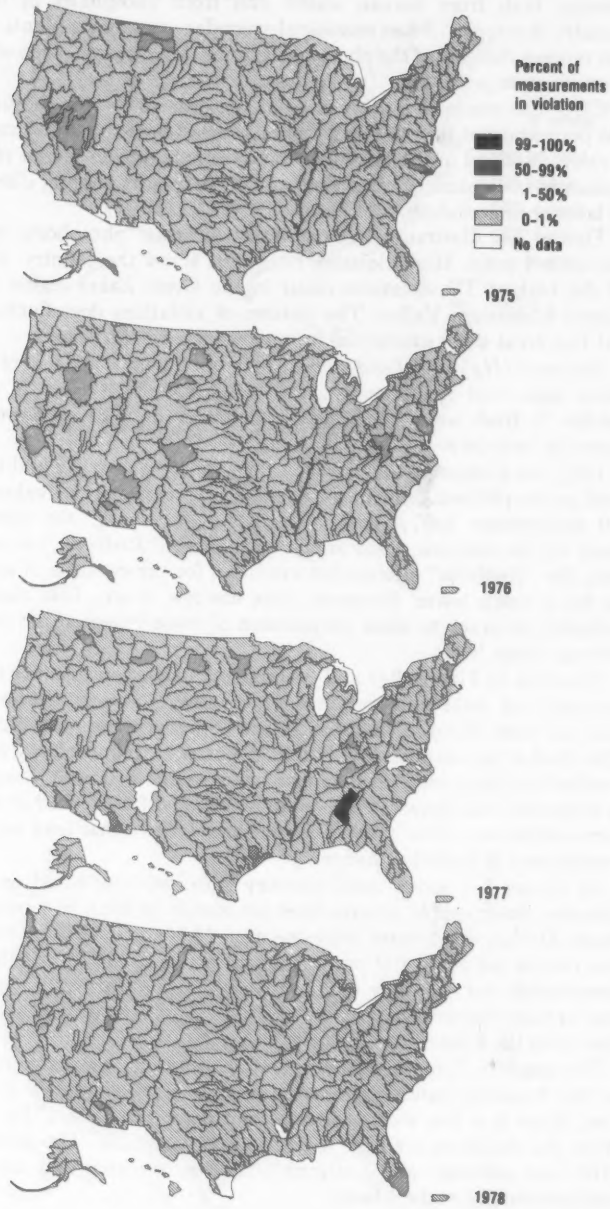
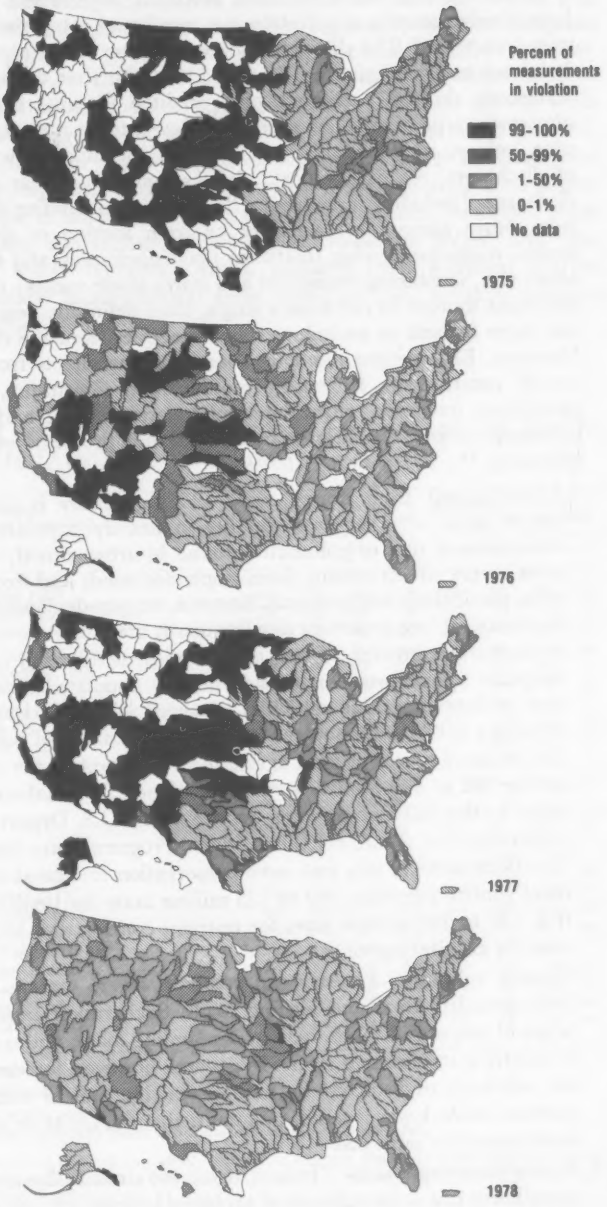


Figure 2–8

Total Lead, 1975–78



Point Versus Nonpoint Sources of Pollution

In dealing with water pollution problems, government regulators have divided sources of pollution into two broad categories: "point" and "nonpoint." The distinction between them is not always clear. Point sources generally are described as those that discharge to a waterbody through a discrete pipe or ditch. Because runoff from almost any type of area can eventually flow into a waterway through pipe, culvert, or ditch, this definition can encompass a wide range of discharges. An EPA report [9] defines point sources as industrial discharges (including large feedlot flows, but not including discharges from other agricultural activities or from mining or silviculture areas), municipal sewage treatment plant discharges, and combined sewer (i.e., combining household and storm sewer wastes) overflows. Nonpoint sources do not have a single, clear definition because various states include or exclude certain categories from the definition. However, EPA defines nonpoint sources as the effects from urban runoff, construction, hydrologic modification, silviculture, mining, agriculture, irrigation return flows, solid waste disposal, and individual sewage disposal.[10] Major nonpoint pollution problems include the following: [11]

- Urban runoff from storm sewers—This generally is cited as a major cause of poor water quality in heavily populated areas. Almost every type of pollutant is found in urban runoff, with the most severe effects coming from suspended solids and toxic materials, particularly heavy metals. Bacteria, oxygen-demanding loads, nutrients, oil, and grease are also frequently present.
- Agricultural activities—These are the most widespread causes of nonpoint source problems outside heavily populated areas. Principal pollutants include pesticides, dissolved solids, nutrients (from fertilizers and natural sources), organic material, and pathogens. The primary source of most agricultural pollutants is the approximately 360 to 420 million acres of cropland. The analysis undertaken by the Soil Conservation Service of the U.S. Department of Agriculture for the Rural Clean Water Program notes that 65 to 75 million acres of this area need conservation treatment for sediment control purposes, 100 to 125 million acres for pesticide control, 150 to 200 million acres for nutrient control, and 12 million acres for salinity control.[12]
- Forestry activities—Forestry can result in severe erosion of soils from denuded areas and logging roads. Such runoff causes high levels of suspended solids, oxygen demanding loads, and nutrients in receiving streams and rivers. In general, however, forested areas are relatively undisturbed by human activity, and as such, they produce much lower levels of pollutants than an urban or agricultural area of the same size.
- Atmospheric deposition—"Fallout" from the air of PCBs, lead, and phosphorus can cause substantial problems in some natural waters.

EPA has subdivided the country into 246 water basins. EPA reports that point sources affect water quality in 91 percent of the basins, and nonpoint sources affect it in 87 percent.[13] Table 2–2, compiled from EPA data, compares regional point and nonpoint source pollution problems for eight major water quality variables. For the nation as a whole, point sources cause problems in more regions than nonpoint sources for half the indicators shown, while the reverse is true for the other half. As shown in the Table 2–2, "bacteria" and "oxygen depletion" are more of a problem from point sources, especially in heavily urbanized areas, reflecting their probable cause in improper municipal sewage treatment, combined sewer overflows, and industrial discharges. "Suspended solids" and "dissolved solids" generally are a problem from nonpoint sources, particularly in agricultural areas, reflecting their probable origin in agricultural soil erosion.

Table 2–2

Point vs. Nonpoint Sources: Percentage of Basins Affected,[a] by Type of Pollutant

Region (number of basins)	Bacteria		Oxygen Depletion		Nutrients		Oil and Grease	
	P	N	P	N	P	N	P	N
Northeast (40)	93	70	93	53	78	63	35	15
Southeast (47)	77	66	89	74	70	57	6	4
Great Lakes (41)	80	51	85	54	71	44	34	20
North Central (35)	89	69	80	66	74	63	0	0
South Central (30)	73	53	87	43	83	63	13	3
Southwest (22)	50	36	36	14	41	45	5	14
Northwest (22)	68	64	55	18	55	55	0	5
Islands (9)	89	89	78	44	56	44	44	0
All Basins (246)	78	61	79	51	69	56	16	9

	Suspended Solids		Dissolved Solids		pH		Toxics[b]	
	P	N	P	N	P	N	P	N
Northeast (40)	70	65	13	10	15	18	58	43
Southeast (47)	26	34	9	4	17	9	34	30
Great Lakes (41)	44	56	27	27	24	37	68	44
North Central (35)	23	80	20	51	14	20	60	66
South Central (30)	30	37	30	70	10	23	43	70
Southwest (22)	14	32	23	68	5	14	9	27
Northwest (22)	23	64	5	14	5	9	18	32
Islands (9)	33	100	11	0	0	0	22	44
All basins (246)	35	54	17	30	14	18	44	45

P=Point Sources.
N=Nonpoint Sources.

[a] In whole or in part.

[b] Includes heavy metals, nonmetal toxics, and pesticides.

Source: U.S. Environmental Protection Agency, *National Water Quality Inventory, 1977 Report to Congress* (Washington, D.C.: U.S. Government Printing Office, 1978) EPA-440/4-78-001, pp. 11, 16.

Nonpoint sources contribute large amounts of most pollutants in virtually every region. Nonpoint sources will cause a larger fraction of U.S. water pollution as point sources increasingly come under control.

This anticipated rise in relative importance of nonpoint over point sources of conventional water pollution has important implications for national policy. U.S. laws and social institutions are far better equipped to deal with point source controls than with nonpoint source controls. An enforcement official can usually identify a person or institution in charge of a point discharge and thus insure compliance with prescribed standards. In contrast, nonpoint sources arise from multiple causes and are dramatically affected by rainfall and storms. As nonpoint sources increase in relative importance as the cause of water pollution, cleanup will become increasingly difficult, involving, for example, questions of technology, economics, management, and enforcement.

Other subsections of this chapter treat other aspects of point and nonpoint water pollution problems and control programs. Nonpoint pollution problems are, of course, inextricably tied to land use planning and decisionmaking, topics addressed in general in several other chapters of this book.

Urban Water Pollution

The nationwide analysis presented above relies on NASQAN data because of its broad overview capability. CEQ also made a closer examination of trends in water pollution at 44 selected cities on major rivers. CEQ used fecal coliform bacteria, dissolved oxyen, biochemical oxygen demand, and total phosphorus as indicators. Most of the cities were selected from the EPA's National Water Quality Surveillance System, which allows comparisons over a period of up to 10 years. Some of the cities selected were reported on in CEQ's Eighth Annual Report. The cities in the analysis are located disproportionately in the East and Midwest because comparable data are not available for western urban centers during the chosen time span.

Table 2–3 lists the violation rates for fecal coliform bacteria, dissolved oxygen, biochemical oxygen demand, and total phosphorus for each of the 44 cities. (See Table 2–1 for threshold values used in determining percentage violation rates.) In many cases, there are marked improvements in downstream water quality over the time spans shown. The decreases in violation rates are no doubt attributable both to industrial pollution control programs and to municipal treatment efforts started in the past decade. Of 149 comparisons of violation rates, 69 showed improvement in water quality, 41 showed degradation, and 39 showed no change. (Of the 39 showing no change, 29 had no violations.) However, the data also show that for half of the cities, levels of at least one of the variables were worse at the end of the time period than at the outset.

At least half of the cities in Table 2–3 have increased the fraction of wastewater receiving secondary treatment by more than 10 per-

cent from 1976 to 1978 (see Table 2–4). Despite the national effort to abate water pollution, we are falling behind in some locations, even at locations investing heavily in municipal sewage works for some pollutants. This is undoubtedly because combined sewer overflows, urban runoff, and some industrial wastes are not treated by the new municipal facilities reported in Table 2–4. In some cases, the improved level of treatment, as reported in Table 2–4, may not have been in place long enough to be reflected in the monitoring data shown in Table 2–3.

CEQ has data that permit an analysis of the effects of successive municipal discharges along the Delaware River. As shown in Figure 2–9, water quality—as measured by percent violation rate for fecal coliform bacteria, dissolved oxygen, and biochemical oxygen demand—deteriorates along the direction of flow until it becomes very poor below Philadelphia. Then water quality improves somewhat below Wilmington.

One city where treatment appears to have paid off is Atlanta (see Figure 2–10). As expected, for both 1972 and 1978, water quality was poorer downstream than upstream. But the difference in quality is lessening. Looking at the 1972 and 1978 data, the figure shows that all of the indicators at the downstream location improved. From 1976 to 1978, Atlanta increased from 33 to 57 percent the fraction of water receiving secondary treatment.

Overall it remains exceedingly difficult to locate high quality data showing water quality "upstream and downstream" and "before and after" the construction and operation of sewage treatment plants built under EPA's Construction Grant Program. In the future, it will become even more important to have accurate measurements, including data from intensive surveys, showing the water quality benefits arising from the Construction Grants Program.

LAKES

Pollution discharges into lakes present different problems than do discharges into rivers and streams. River waters have high flushing rates and can usually cleanse themselves rapidly of dissolved pollutants if waste discharges are stopped. (Pollutants trapped in river sediments can take much longer to disperse, however. For example, the James River in Virginia may well have Kepone contaminated sediments beyond the year 2000.) Most lakes, however, flush very slowly, if at all. Wastes introduced into a lake can remain for years if not centuries. As many as two-thirds of the nation's lakes may have serious pollution problems as a result.[14] Urban lakes are particularly susceptible to man's influence. An estimated 80 percent of more than 3,700 urban lakes in the United States are significantly degraded, and yet, they offer potential aesthetic and recreational value to more than 94 million metropolitan residents.[15]

Table 2–3

Comparison of Violation Rates for Different Years at Downstream Monitoring Stations for 44 Cities

(violation rate in percent)

Site	Population in Thousands	Fecal Coliform Bacteria (FC)				Dissolved Oxygen (DO)				Biochemical Oxygen Demand (BOD)				Total Phosphorus (TP)			
		Rate	Year	Rate	Year	Rate	Year	Rate	Year	Rate	Year	Rate	Year	Rate	Year	Rate	Year
Hartford	156	100	1968	90	1976	5	1968	0	1978					53	1970	75	1978
Nashua	56	88	1974	69	1978	0	1972	36	1978					100	1972	95	1978
Albany	73					0	1974	0	1978					20	1968	10	1978
Schenectady	77					0	1972	0	1978					75	1968	5	1978
Easton	30	79	1968	27	1978	0	1968	10	1978	0	1968	11	1978	100	1973	9	1978
Trenton	105	48	1968	50	1978	18	1968	6	1978	4	1968	1	1978				
Philadelphia	1,978	87	1968	89	1978	73	1968	48	1978	18	1968	4	1978				
Wilmington	80	61	1968	26	1978	50	1968	22	1978	12	1968	2	1978				
Frederick	24	94	1968	64	1976	0	1968	7	1978	14	1970	19	1978	100	1968	90	1978
Hickory	21	80	1970	45	1976	0	1970	0	1978					36	1972	62	1978
Charlotte	241	100	1968	97	1976	55	1968	38	1978	50	1968	52	1976	100	1968	100	1978
Columbia	114	61	1970	43	1978	0	1968	0	1978	3	1970	4	1978	100	1970	14	1978
Harrisburg	66	38	1968	76	1976	0	1968	0	1978	10	1968	4	1978	25	1968	26	1978
Wilkes-Barre	59	83	1970	85	1976	0	1970	0	1978	4	1972	14	1978	29	1972	23	1978
Richmond	250	25	1972	10	1978	0	1972	2	1978	10	1972	2	1978	80	1972	82	1978
Roanoke	97	63	1972	100	1978	0	1972	0	1978	0	1972	4	1978	0	1972	8	1978
Atlanta	497	100	1968	67	1978	63	1968	16	1978	32	1968	28	1978	100	1968	97	1978

Lansing	132	83	1968	71	1977	27	1972	10	1977	100	1968	40	1977	100	1968	98	1977
Grand Rapids	198	16	1968	23	1978	0	1968	0	1978	7	1968	28	1978	100	1970	62	1978
Detroit	1,511	59	1970	48	1978	2	1968	2	1978	1	1973	0	1978	91	1968	18	1978
Minneapolis	434	100	1968	88	1978	34	1968	11	1978	58	1970	35	1978	100	1968	100	1978
Cleveland	751					0	1974	0	1978					100	1974	100	1978
Nashville	448	80	1970	82	1978	100	1970	94	1978	0	1970	0	1978	75	1970	61	1978
Chattanooga	119	60	1970	0	1976	17	1970	0	1976	0	1970	0	1976	55	1970	60	1978
Springfield	119	86	1972	76	1976	32	1972	30	1976					96	1972	100	1978
St. Louis	608	100	1972	78	1976	0	1972	0	1976					100	1970	100	1976
Kansas City	507	100	1972	100	1978	0	1972	0	1978					93	1972	100	1976
Topeka	125	71	1972	100	1976	0	1972	0	1976					100	1972	100	1978
Lawrence	46	100	1972	100	1976	0	1972	0	1976					88	1972	100	1976
Lincoln	150	100	1972	71	1976	41	1972	0	1976					100	1972	100	1976
Omaha	347	100	1972	100	1978	0	1972	0	1978					95	1972	100	1976
Sioux City	89	100	1972	100	1976	0	1972	0	1976					36	1972	47	1976
Waterloo	76	95	1972	67	1976	0	1972	0	1976					100	1972	100	1976
Des Moines	200	100	1968	90	1978	46	1968	9	1978					80	1968	53	1978
Albuquerque	244	100	1968	83	1976	0	1968	6	1976	40	1968	56	1974	100	1970	90	1976
Carlsbad	26					43	1970	0	1976					88	1972	91	1976
Denver	515	91	1968	92	1978	6	1968	45	1978	93	1968	95	1978	100	1970	100	1978
Carson City	15	14	1968	11	1976	0	1968	0	1978	4	1968	7	1976				
Casper	39	100	1968	67	1976	0	1968	0	1978	6	1968	0	1974	73	1968	22	1978
Bismarck	35	0	1972	0	1976	0	1972	0	1978					31	1968	6	1978
Billings	62	50	1970	90	1976	0	1970	0	1978	0	1970	0	1978	46	1972	19	1978
Sioux Falls	73	100	1970	52	1978	0	1970	0	1978	100	1970	50	1974	100	1970	97	1978
Salt Lake City	177	40	1972	56	1976	22	1972	26	1978	95	1968	85	1976	100	1972	100	1978
Reno	73	3	1968	13	1976	3	1968	2	1976	7	1968	3	1976				

Table 2–4

Percent of Wastewater Receiving Secondary Treatment in Selected Cities

City	1976	1978
Hartford	55	75
Albany	42	92
Trenton	26	50
Philadelphia	15	29
Wilmington	3	95
Charlotte	87	99
Harrisburg	15	97
Richmond	67	80
Atlanta	33	57
Lansing	60	98
Grand Rapids	10	99
Detroit	1	99
Minneapolis	3	99
Cleveland	1	96
Nashville	12	97
Chattanooga	11	97
Springfield	12	98
Denver	2	99
Billings	0	95
Sioux Falls	0	99
Salt Lake City	42	99
Reno	4	99

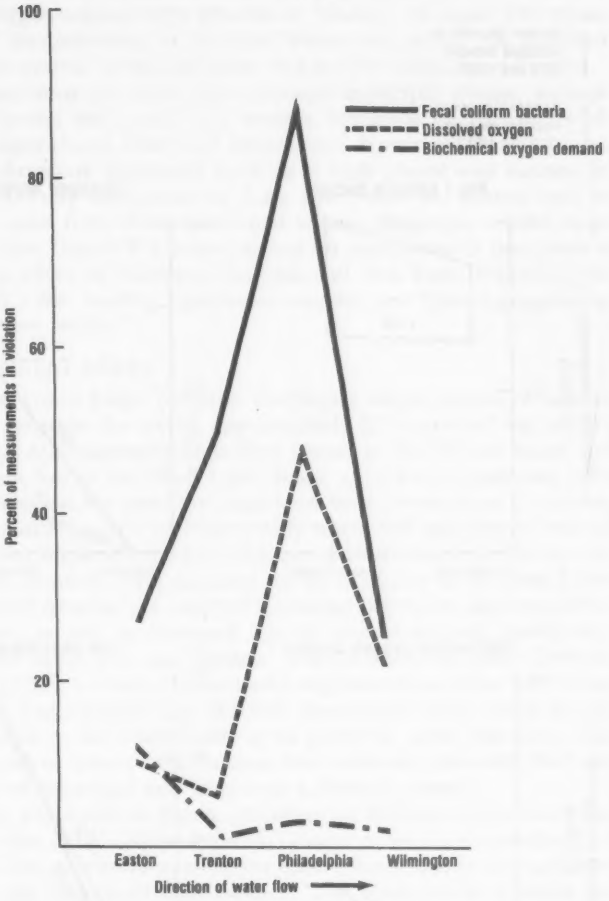
Source: U.S. Environmental Protection Agency, *1978 Needs Survey, Cost Estimates for Construction of Publicly-Owned Wastewater Treatment Facilities* (Washington, D.C.: U.S. General Services Administration, 1979), EPA–430/9–79–001.

When pollution discharges cause excessive nutrient loading to a lake, the result is the hastening of a natural biological process known as eutrophication. Eutrophication is an aging process for lakes that usually begins with increased plant production. As plants die, settle to the bottom, and decay, they can deplete the dissolved oxygen in the water and gradually fill in the lake. Human activities in a lake's watershed can speed up this process from one of centuries to one of decades. Eutrophication from human activities, or "cultural" eutrophication, can produce nuisance blooms of algae, kill fish by depleting dissolved oxygen, and render the water unfit for recreation. The National Eutrophication Survey conducted by EPA between 1972 and 1977 found that 68 percent of the approximately 800 lakes sampled were classified as eutrophic,* with another 4 percent classified as hypereutrophic.[16]

* A lake's trophic state or condition is a composite measure of its productivity or fertility. Resultant water quality is usually based on water clarity and color, plant productivity and biomass, and other chemical and biological measures. A eutrophic lake usually has murky, greenish water and levels of plant productivity and chlorophyll. An oligotrophic lake has clear, transparent water and low plant productivity. A mesotrophic lake is an intermediate state between oligotrophic and eutrophic. A hypereutrophic lake has extremely high levels of plant biomass and very murky water.

Figure 2–9

Pollution Levels Near Urban Centers on the Delaware River and Estuary, 1978

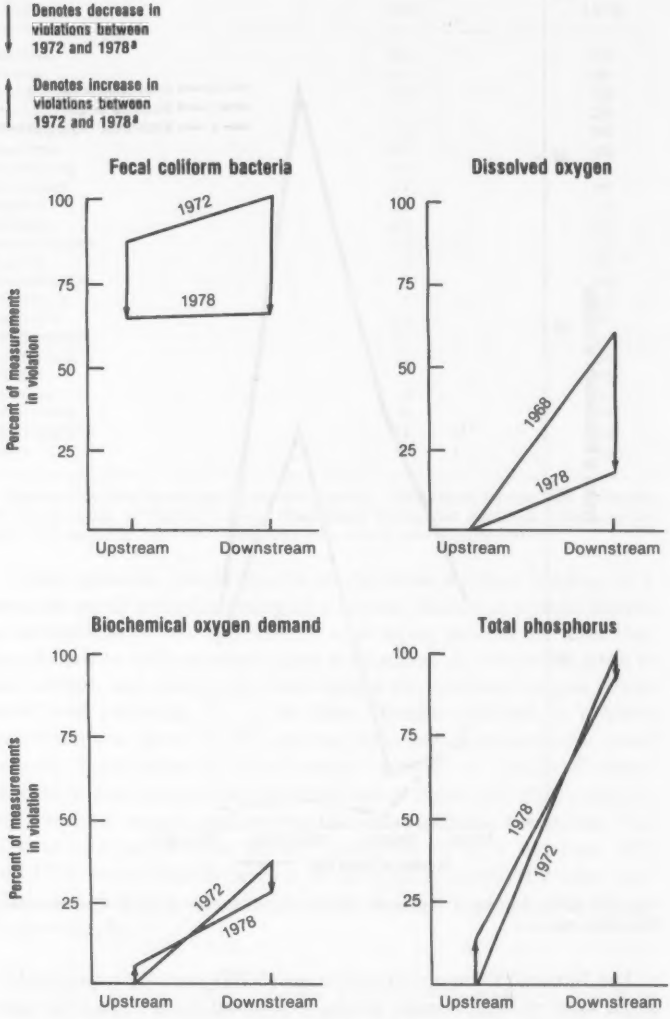


Source: CEQ analysis of data from U.S. Geological Survey and U.S. Environmental Protection Agency.

The National Eutrophication Survey (NES) sampled water quality in the lakes as well as many stream inputs and outflows to determine the trophic status of the lakes sampled. Unfortunately, the NES was a one-time project and no continuing, national reporting system exists to monitor the quality of lakes as there is for rivers and streams.[17] The NES thus represents the latest large-scale compilation of data on lake water quality.

Figure 2–10

Pollution Levels Upstream and Downstream of Atlanta, Ga., 1972 and 1978 [a]



[a] Time interval for dissolved oxygen is 1968 to 1978.

Source: CEQ analysis of data from U.S. Geological Survey and U.S. Environmental Protection Agency.

Phosphorus is generally recognized as the most troublesome nutrient in wastes discharged into lakes. Phosphorus is usually the limiting nutrient for growth of algae and other plants in fresh water aquatic systems; therefore wastes carrying high levels of phosphorus can trigger sudden, large growths or "blooms" of algae. The subsequent decomposition of the algal bloom can reduce the dissolved oxygen content of the lake water to a level at which fish suffocate.

Phosphorus can enter lakes through municipal sewage, seepage from sewers and septic tank systems, industrial discharges, runoff from agricultural areas, and atmospheric deposition. Human wastes and phosphate detergents produce a high phosphorus content in sewage. Fully one-quarter of Lake Erie's total phosphorus load in 1978 came from direct municipal sewage discharges, with a large part from Detroit.[18] A statewide ban on phosphorus in detergents is now in effect for Michigan, Indiana, and New York; Wisconsin has passed a law limiting phosphorus content, and Ohio is considering legislative action.[19]

THE GREAT LAKES

The Great Lakes comprise the largest single volume of surface fresh water in the world, approximately 20 percent of the world's supply. Approximately 37 million people in the United States and Canada live in the Great Lakes Basin, an industrial center of both countries. In the past, the lakes have been perceived as a virtually inexhaustible source of high quality water and are counted among the most important natural resources in North America. Human activities, however, have degraded the water quality of the Great Lakes in recent decades as a result of increasing population and industrialization, as well as increased use of water and land, particularly around Lakes Erie and Ontario. The International Joint Commission (IJC), a bilateral board with representatives from the United States and Canada, has identified the current major water quality problems in the Great Lakes to be persistent toxic chemicals, high phosphorus inputs, contributions from airborne pollutants, and disposal of municipal and hazardous industrial wastes.[20]

The International Reference Group on Pollution From Land Use Activities (PLUARG) of the IJC characterizes the western basin of Lake Erie as eutrophic, while the eastern basin of Erie and Lake Ontario are considered mesotrophic.[21] The open waters of Lakes Superior, Huron, and Michigan are considered oligotrophic[22] (see Table 2–5). The nearshore areas of all the lakes, however, have localized areas of water quality deterioration (see Figure 2–11). Much of the eutrophication problem in Lakes Erie and Ontario is caused by continued high loads of phosphorus and nitrogen from municipal sewage, as well as by inputs from agricultural and urban runoff, and from the atmosphere.[23] Municipal treatment facilities were considered adequate for only 64 percent of the sewered population in the U.S. portion of the Great Lakes Basin in 1978, although this did not include projects underway. The municipal phosphorus

Table 2–5

Great Lakes Water Pollutants

Parameters for Which a Great Lakes Water Quality Problem Has Been Identified

Pollutant	Type of Problem		Diffuse Sources			Point Sources
	Lakewide	Near shore or Localized	Land Runoff	Atmos-phere	In-Lake Sediments	
Phosphorus[a]	Yes	Yes	Yes	Yes	Yes[a]	Yes
Sediment[b,a]	No	Yes	Yes[a]	Negligible	Under some condi-tions	Negligible
Bacteria of Public Health Concern	No	Yes	Minor[d]	No	No	Yes
PCB[e]	Yes	Yes	Yes	Yes	Yes	Yes
Pesticides[e] (Past)	Yes[e]	Yes[e]	Yes	Yes	Yes	No
Industrial Organics[e]	Yes	Yes	Yes	Yes	Yes	Yes
Mercury[e]	Yes	Yes	Minor	Yes	Yes	Yes
Lead[e]	Potential[f]	Potential[f]	Yes	Yes	Yes	Yes

Parameters for Which No Great Lakes Water Quality Problem Has Been Identified, but Which May be a Problem in Inland Surface Waters or Ground Waters

Nitrogen	No	No[g]	Yes	Yes	Minor	Yes
Chloride	No	No[h]	Yes	Negligible	No	Yes
Pesticides[e] (Present)	No	No	Yes	No [i]	No	Yes
Other Heavy Metals	Potential[f]	Potential[f]	Yes	Yes	Yes	Yes
Asbestos[j]	No	Yes	No	[a]	Yes	Yes
Viruses[k]	← No Data Available →					Yes
Acid Precipitation	No	No[l]	No	Yes	No	No

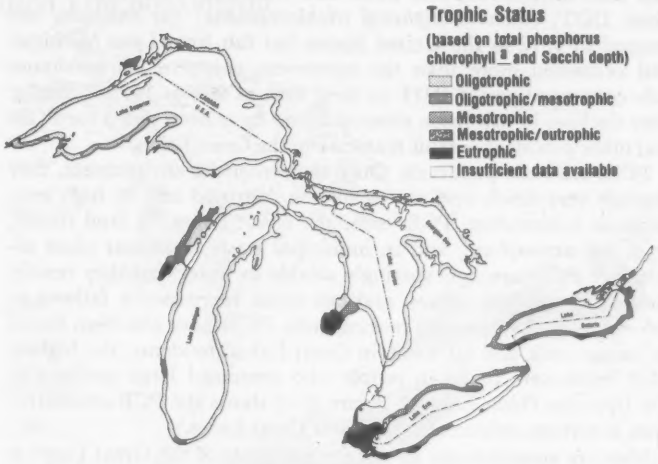
[a] Sediment per se causes local problems; phosphorus and other sediment-associated contaminants have lakewide dispersion.

[a] Percentage unknown; not considered significant over annual cycle
[b] May contribute to problems other than water quality (e.g., harbor dredging)
[c] Including streambank erosion.
[d] Land runoff is a potential, but minor source; combined sewer overflows generally more significant
[e] Some residual problems exist from past practices
[f] Possible methylation to toxic form
[g] Some inland ground water problems
[h] Some local problems exist in nearshore areas due to point sources
[i] New pesticides have been found in the environment; continued monitoring is required
[j] See Upper Lakes Reference Group Report
[k] Better detection methods needed
[l] A potential problem for smaller, soft water, inland lakes

Source: International Reference Group on Great Lakes Pollution from Land Use Activities (PLUARG), *Environmental Management Strategy for the Great Lakes System, Final Report to the International Joint Commission* (Windsor, Ontario: International Joint Commission, 1978), p. 18.

Figure 2–11

Nearshore Trophic Condition of the Great Lakes



Note: Nearshore zones not drawn to scale.

Source: The International Reference Group on Great Lakes Pollution from Land Use Activities (PLUARG), *Environmental Management Strategy For The Great Lakes System, Final Report to the International Joint Commission* (Windsor, Ontario: International Joint Commission, 1978), p. 21.

load to Lakes Erie and Ontario still far exceeds the limitations established in the 1978 Great Lakes Water Quality Agreement between the United States and Canada. Detroit remains the largest single municipal source of phosphorus to Lake Erie, accounting for 48 percent of the 1978 municipal load to the lake from plants discharging in excess of 1 million gallons per day, even though its phosphorus discharge has been reduced by more than 80 percent in the past 8 years.[24]

The IJC has noted that the increased use of chemical treatment for phosphorus removal has produced increased quantities of sludge. Larger communities frequently must incinerate sludge as a disposal method. Incineration, however, can cause air pollution problems and usually consumes large amounts of energy. The phosphorus removal capability of some larger municipal plants in the basin, usually the most serious phosphorus polluters of the Great Lakes, is limited by sludge generation and disposal problems.[25] Land application of sludges in the basin is presently restricted primarily to some smaller municipalities because of land requirements and high levels of metals in sludges, although industrial pretreatment will likely eliminate the latter concern.

Persistent toxic chemicals also remain a significant problem in the Great Lakes, even after the manufacture or use of some toxic chemicals has been stopped. This is due both to their persistence in

the environment and their biomagnification in food chains, as well as to the size and generally slow flushing of the Great Lakes, which can keep them in the lake water and sediments for long periods of time. DDT, (*dichoro diphenyl trichloroethane*) for example, was banned in 1972 in the United States, but fish from Lake Michigan still contained more than the agreement objective for maximum safe concentrations of DDT in their flesh as late as 1976.[26] Similar slow declines in fish tissue concentrations have been noted for PCBs and other persistent organic materials in the Great Lakes.

PCBs are toxic pollutants. Once they enter the environment, they degrade very slowly and can usually be destroyed only by high temperature incineration. PCBs enter the Great Lakes via land runoff, from the atmosphere, and in municipal waste treatment plant effluents.[27] PCBs are only sparingly soluble in water, but they readily accumulate in fatty tissues, and can cause reproductive failures in fish-eating birds, especially herring gulls. PCBs have also been found in human milk and fat tissue in Great Lakes' residents; the highest PCB levels were found in people who consumed large amounts of fish from the Great Lakes.[28] Figure 2–12 shows the PCB concentrations in surface sediments in the lower Great Lakes.

Mercury accumulation in surface sediments of the Great Lakes is also a matter of concern. As noted earlier, inorganic mercury can be converted by microorganisms in the sediments into methyl mercury, an organic form of mercury that is a strong human nerve poison, and can be readily bioaccumulated. Figure 2–13 shows that Lake St. Clair is a major source of mercury to western Lake Erie, even after the closing of the point source of mercury to the lake. Lake Ontario also has high concentrations of mercury, particularly in its eastern basin.[29]

Lead concentrations in Great Lakes fish are not considered a problem at present, although studies are underway to assess the potential for the methylation of lead by the same process as for mercury. The major input of lead to the Great Lakes is from nonpoint sources, especially automobile exhaust into the atmosphere and subsequent deposition, either directly onto the lake surface or onto the land with later runoff to the lakes. Nonpoint sources range from 84.7 percent of the lead load for Lake Erie, to 98.7 percent for Lake Ontario, and 99.6 percent for Lake Superior.[30] Figure 2–14 shows the lead concentrations in surface sediments of the Great Lakes.

In addition to these and other known toxic or potentially toxic substances, development of more sophisticated analytical methods has recently led to the identification of previously undetected contaminants in the Great Lakes system. Thirty-eight previously undetected contaminants were identified in 1977 in fish and herring gulls in the Lake Ontario basin. These include 14 industrial pollutants and agricultural pesticide derivatives. The remaining 24 contaminants are polynuclear aromatic hydrocarbons, including nine suspected carcinogens. It is not known whether these latter 24 are all derived from human activities, or from natural sources as well.[31] The full

Figure 2–12

PCB Concentrations in Surface Sediments of Lakes Huron, Erie, and Ontario

PCB Concentrations (ppb = parts per billion)

- Less than 10 ppb
- 10–20 ppb
- 20–50 ppb
- 50–100 ppb
- More than 100 ppb

Note: The measurements used in preparing this map were taken in the following years: Lake Huron, 1969 and 1973: Lake Erie, 1971; Lake Ontario, 1968. The IJC believes that the maps are reflective of conditions through the mid-1970s.

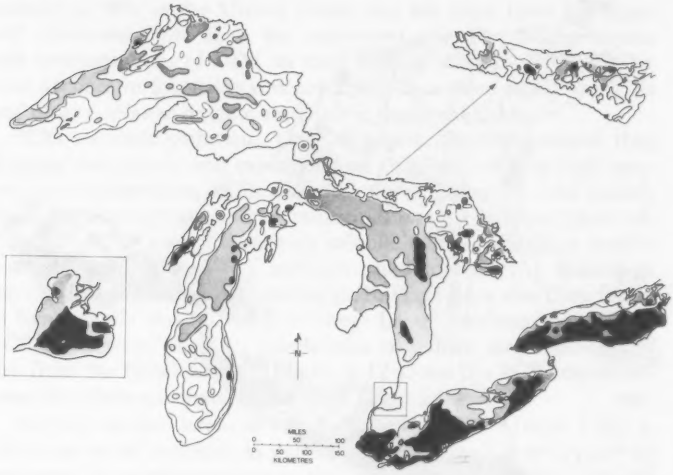
Source: The International Reference Group on Great Lakes Pollution from Land Use Activities (PLUARG), *Environmental Management Strategy For The Great Lakes System, Final Report to the International Joint Commission* (Windsor, Ontario: International Joint Commission, 1978), p. 41.

scope of the threat of these various compounds to human health and the environment has not yet been defined.

Airborne pollutants are of particular concern for the Great Lakes. The IJC has reported that substantial quantities of nutrients and toxic materials are being deposited in the Great Lakes Basin from the atmosphere, both in rainfall and dry fallout. These deposits may fall directly into the lakes, or may enter indirectly from land runoff following precipitation in the basin. Further, the sources of these pollutants may be far distant from the Great Lakes themselves. The atmospheric contributions of phosphorus directly to the Great Lakes in 1978 were: Lake Superior, 59 percent; Lake Michigan, 27 percent; Lake Huron, 40 percent; Lake Erie, 4 percent; and Lake Ontario, 7 percent.[32] Of even greater significance are the atmospheric inputs of potentially toxic materials. PCBs and lead are two examples

Figure 2–13

Mercury Concentrations in Surface Sediments of the Great Lakes



Mercury Concentrations (ppb = parts per billion)

- Less than 50 ppb
- 50–100 ppb
- 100–500 ppb
- 500–1000 ppb
- 1000–2000 ppb
- More than 2000 ppb

Note: The measurements used in preparing this map were taken in the following years: Lake Ontario, 1968; Lake Huron, 1969 and 1973; Lake Erie, 1971; Lake Superior, 1973; Lake Michigan, 1975. The IJC believes that the maps are reflective of conditions through the mid-1970s.

Source: The International Reference Group on Great Lakes Pollution from Land Use Activities (PLUARG), *Environmental Management Strategy For The Great Lakes System, Final Report to the International Joint Commission* (Windsor, Ontario: International Joint Commission, 1978), p. 31.

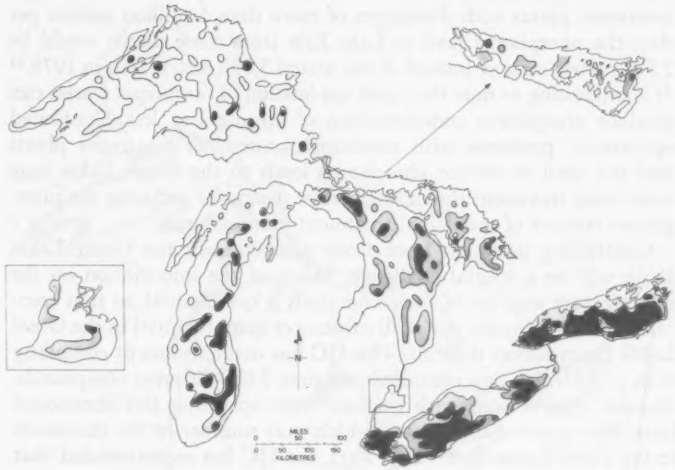
of materials that are contributed in significant amounts to the Great Lakes from atmospheric sources. One study suggests that atmospheric transport and deposition are the major means by which PCBs enter Lake Superior.[33] The consequences of airborne pollutants are also being seen in the generation of acid rainfall in some areas of the Great Lakes Basin.

Great Lakes Programs

Programs to reduce pollution and improve water quality in the Great Lakes are difficult to design and implement because the lakes are extremely large and complex and receive pollutants from many different sources. The Great Lakes Basin also contains many different jurisdictions, because the Great Lakes constitute a large part of the international border between the United States and Canada. The

Figure 2–14

Lead Concentrations in Surface Sediments of the Great Lakes



Lead Concentrations (ppb = parts per billion)

- Less than 50 ppb
- 50–100 ppb
- 100–150 ppb
- More than 150 ppb

Note: The measurements used in preparing this map were taken in the following years: Lake Ontario, 1968; Lake Huron, 1969 and 1973; Lake Erie, 1971; Lake Superior, 1973; Lake Michigan, 1975. The IJC believes that the maps are reflective of conditions through the mid-1970s.

Source: The International Reference Group on Great Lakes Pollution from Land Use Activities (PLUARG), *Environmental Management Strategy For The Great Lakes System, Final Report to the International Joint Commission* (Windsor, Ontario: International Joint Commission, 1978), p. 35.

IJC is the mechanism for cooperation between the two countries in matters relating to the Great Lakes' water quality. The IJC's responsibilities in the Great Lakes stem from the 1972 Great Lakes Water Quality Agreement. A new, revised agreement [34] was signed on November 22, 1978, which reaffirms both countries' commitment to restore and enhance the water quality of the Great Lakes. The IJC maintains a Great Lakes Water Quality Board and a Science Advisory Board, as well as other reference groups from time to time, to investigate pollution problems in the lakes and to determine solutions to these problems.

To reduce the amount of phosphorus entering to the Great Lakes, the IJC has recommended that effluents from municipal sewage treatment plants discharging in excess of 1 million gallons per day contain no more than 1 mg/l phosphorus, a limitation established in the 1972

agreement. Many municipalities, however, are still not meeting the 1 mg/l standard. Buffalo and Syracuse have corrective programs underway to meet this standard, but Detroit, Toledo, Niagara Falls, and Cleveland have experienced major operational difficulties. If the municipal discharge standard were met by all the municipal treatment plants with discharges of more than 1 million gallons per day, the phosphorus load to Lake Erie from these plants would be 2,524 metric tons/yr instead of the actual 5,835 metric tons in 1978.[35] It is interesting to note that land application of municipal wastes can produce phosphorus concentrations of 0.1 mg/l or less. Continued operational problems with municipal wastewater treatment plants and the need to reduce phosphorus loads to the Great Lakes may make land treatment the most effective means for reducing the phosphorus content of municipal treatment plant effluents.

Controlling pollution from toxic substances in the Great Lakes Basin will be a special challenge. Much of the information on the manufacture and use of toxic chemicals is confidential, so that compilation of a complete list of all substances manufactured in the Great Lakes Basin is very difficult. The IJC has made a start at compiling such a list, which now contains more than 2,800 different compounds. Another area of concern is leachate from operating and abandoned hazardous waste disposal sites, which may number in the thousands in the Great Lakes Basin. As a start, the IJC has recommended that both governments develop an accurate inventory of all hazardous waste disposal sites in the basin.[36]

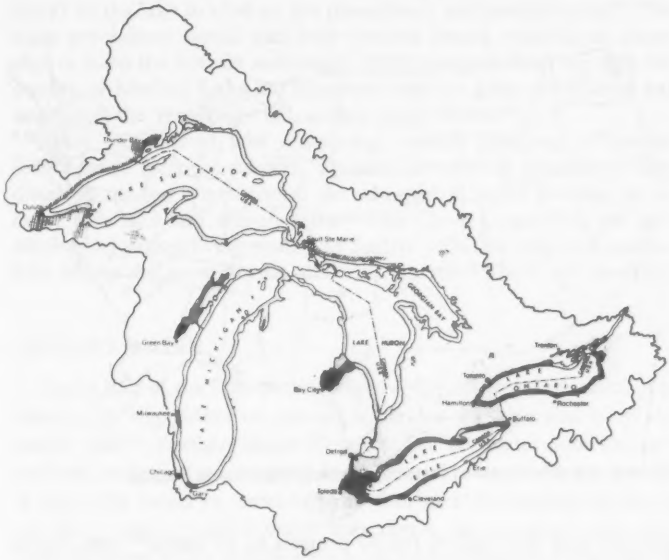
Attempting to control point source phosphorus loads has been an expensive undertaking in the Great Lakes Basin, but controlling nonpoint sources will be even more costly. The IJC's International Reference Group on Pollution From Land Use Activities (PLUARG) estimated that to achieve target phosphorus loads for southern Lake Huron, and Lakes Erie and Ontario, the minimum cost would be about $105 million per year, with point source controls costing at least $20 million and nonpoint sources costing $85 million of the total cost.[37] These estimates are based on one possible combination of point and nonpoint source phosphorus reduction options that would allow the achievement of the target loads. Selection of other options are possible and may be more effective or attractive in specific areas of the Great Lakes Basin. This estimated cost is based on the assumption that the required 1 mg/l effluent limitations for phosphorus will have been achieved in the Great Lakes Basin. Land application of wastewaters was not considered by PLUARG as a method for reducing phosphorus loads to the Great Lakes. Areas requiring acceleration of nonpoint source programs in the Great Lakes Basin are shown in Figure 2–15.

Clean Lakes Program

Once a lake has become eutrophic, merely stopping the source of pollution will not necessarily result in a significant improvement in water quality. Nutrient wastes such as nitrogen and phosphorus are

Figure 2–15

Phosphorous-Contributing Areas and Nearshore Trophic Status in the Great Lakes Basin, Mid-1970s



Trophic status
(based on total phosphorus chlorophyll a and Secchi depth)

- Oligotrophic
- Oligotrophic/mesotrophic
- Mesotrophic
- Mesotrophic/eutrophic
- Eutrophic
- Insufficient data available

Phosphorous-contributing areas

- Areas where soil, land use, and hydrologic conditions produce the sediment and phosphorus loads to the Great Lakes.
- Areas with the potential to produce large sediment and phosphorus loads to the Great Lakes.

Note: Nearshore zones not drawn to scale.

Source: Dennis Gregor and Walter Rast, "Trophic Characterization of U.S. and Canadian Near-Shore Zones of the Great Lakes," submitted to the International Reference Group on Great Lakes Pollution from Land Use Activities (PLUARG) (Windsor, Ontario, International Joint Commission, 1979).

often recycled into the lake from sediments and, given a slow flushing rate, can continue to cause water quality problems for years. However, the eutrophication process can usually be slowed and sometimes reversed. EPA administers the Clean Lakes Program for the purpose of granting funds to states and localities to restore publicly owned fresh water lakes.[38] As of February 1, 1979, the program had

Figure 2–16

Clean Lakes Program Grants Proposed and Approved, as of February 1, 1979

(grants approved/proposals submitted)

Source: U.S. Environmental Protection Agency, Clean Lakes Program.

granted over $33 million for 90 projects in 33 states[39] (see Figure 2–16). The program grants matching funds on a 50 percent federal, 50 percent state basis.

As of July 1978, the program also began providing federal assistance to states to cover 70 percent of the eligible costs for classifying and identifying the trophic status of lakes and developing priorities for restoration.[40] The classification grants are for a maximum of $100,000.[41] Changes proposed in January 1979 provide that to be eligible for any Clean Lakes Program assistance after January 1, 1982, states must have completed their identification and classification survey, and developed a priority list for lakes needing restoration. The January 1979 changes also proposed to make available grants for diagnostic and feasibility studies of potential rehabilitation measures, funded on a 70 percent federal share up to $100,000.[42]

An example of a lake restored under the Clean Lakes Program is Medical Lake near Spokane, Wash. The National Eutrophication Survey classified the 158-acre lake as hypereutrophic in 1975.[43] Large blooms of nuisance algae had spoiled the lake for recreational purposes, produced noxious odors, and threatened the fish population. Investigators determined that phosphorus released from the bottom sediments caused the algal blooms and that internal cycling of the nutrients within the lake would continue. The homes surrounding

the lake are all sewered and the lake has no outside source of phosphorus.[44]

With $128,217 from EPA's Clean Lakes Program and matching funds from the state and the town of Medical Lake, liquid alum (aluminum sulfate) was added to the hypolimnion (bottom water layer) of the lake to bind up the phosphorus and precipitate it.[45] The alum precipitate would also help prevent future recycling of phosphorus from the bottom sediments. Preliminary findings are that the quality of Medical Lake has improved and the alum application has prevented the recurrence of summer algal blooms.[46]

Other methods of lake restoration include dredging of bottom sediments to remove nutrients, artificial aeration to maintain a high dissolved oxygen content, and drawdown and rapid flushing to remove nutrients and other wastes.[47] The Clean Lakes Program also emphasizes preventive measures to control pollution sources around a lake before the more drastic measures described above are needed.[48]

GROUND WATER

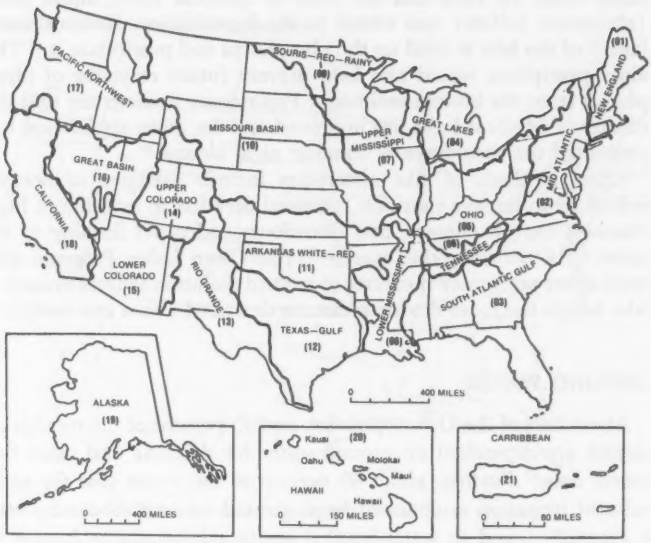
About half of the U.S. population and 95 percent of the rural population are dependent on ground water for drinking and other domestic uses.[49] Further, about 40 percent of the water used for agricultural irrigation is obtained from ground water.[50] Ground water is generally found in water-bearing geological formations known as aquifers, through which water may move, at very slow rates, over vast distances. Some aquifiers are small while others may cross several states. Ground water in an aquifer is generally of good quality because the upper layers of the soil have enormous capacity to decompose, bind, and filter out contaminants before the water reaches the aquifer. Most of the U.S. ground water supply in the uppermost several hundred feet of the earth's mantle is potable and usable for most purposes. However, there are critical areas where the natural supply is of poor quality, and in some areas the potable supply is being degraded through human use and contamination. Deterioration of ground water quality and insufficient ground water supply are two major problems throughout much of the United States. Problems relating to excessive ground water withdrawals are discussed in Chapter 6.

Assessment Problems

The extent of ground water quality problems and the potential these problems have for significantly limiting its use are difficult to assess, largely because the data on ground water quality are inadequate. Information on ground water quality and current problems are summarized in Table 2–6, according to regions defined by the U.S. Water Resources Council [51] (see Figure 2–17).

Figure 2–17

Water Resources Regions



Source: U.S. Water Resources Council, *The Nation's Water Resources 1975–2000* (Washington, D.C.: U.S. Government Printing Office, 1979), Vol. 1, p. 5.

The U.S. Geological Survey is developing a National Ground Water Quality Monitoring program in cooperation with the states to improve general monitoring efforts, but it will be a long time before adequate information is available. At least two problems must be solved in developing adequate information on ground water quality and trends:

- Sampling problems—Ground water *in situ* can only be sampled from wells, springs, or by other means of underground access. However, such samples, when analyzed, represent the groundwater quality only at one geographic point. Interpretation of samples involves extrapolation of the point results to large volumes of ground water, a procedure which may or may not be accurate.
- System definition—Understanding ground water systems requires knowing where they are replenished, where they discharge, rates and direction of water movement, hydrogeology, and so forth. The understanding of the geochemical limitations on ground water systems is necessary to allow some estimate of how and to what extent people affect ground water quality and whether human activities will result in significant short-term or long-term problems. Without developing a basic understanding of each ground water system,

Table 2–6

Summary of Ground Water Quality in the United States

Number	Region	Ground Water Quality
1	New England	Local problems include leachates from septic tanks and sanitary landfills and in some areas high concentrations of sulfate, sulfide, manganese, and organic chemical wastes. Salt water intrusion in some coastal areas is a growing problem.
2	Mid-Atlantic	In most parts of the region, fresh water of satisfactory chemical quality for virtually all uses occurs to depths of several hundred feet and in some areas to more than 1,000 feet. Locally, high concentrations of sulfate, sulfide, iron, manganese, and fluoride are found. Human activities have produced contamination from septic tanks, sanitary landfills, organic chemical wastes, highway deicing salt, and saltwater intrusion in some coastal areas.
3	South Atlantic—Gulf	Ground water of good quality is available in nearly all of the region. Simple treatment for excessive iron, corrosiveness, and hardness is common. Salt water intrusion has occurred in some coastal areas. Local contamination has occurred through drainage wells and canals and through disposal of waste organic chemicals.
4	Great Lakes	Good quality ground water exists in most of the region. Local problems include zones of highly saline water, excessive iron in glacial deposits, deep disposal of toxic wastes, and pollution of shallow ground water from industrial wastes.
5	Ohio	Fresh ground water is usually found at depths of less than 500 feet; the estimated amount stored in the glacial and alluvial deposits of the region totals 23,000 billion gallons. The deeper water in older formations generally is of poor quality and locally has migrated into heavily pumped aquifers. Industrial and municipal waste disposal has polluted the supply in numerous local areas.
6	Tennessee	Contamination of ground water occurs locally due to sink holes, septic tank and municipal waste disposal, and the shallow depth at which naturally mineralized water is found.
7	Upper Mississippi	Aquifers generally contain water of good quality. Iron, hardness, sulfate, and chloride in excess of drinking water standards are problems in some areas. Pollution has occurred locally from chemical spills and waste disposal.
8	Lower Mississippi	Multiple freshwater aquifers of sand and gravel underlie about 90 percent of the region. Pollution from oil field and other industrial wastes occurs in the southern part of the region, and salt water encroachment has developed along parts of the Gulf Coast.
9	Souris-Red-Rainy	Shallow sand and gravel aquifers are the most productive in the region and generally contain ground water of good quality. Disposal of municipal and industrial wastes and use of fertilizers have polluted local areas in the Red and Souris River Basins. Salt water has migrated upward from lower strata, contaminat-

Table 2–6 (continued)

Number	Region	Ground Water Quality
9	Souris-Red-Rainy—Cont.	ing aquifers in parts of northwestern Minnesota and northwestern North Dakota.
10	Missouri	Sand and gravel aquifers contain ground water of good quality; in others, water quality is highly variable. Saline water is common, particularly at lower depths. Pollution from industrial and municipal wastes has occurred in several areas.
11	Arkansas-Red-White	Pollution has occurred locally from waste disposal, notably from mining and sewage ponds in the carbonate rocks of the Ozarks and Missouri. Water quality has been degraded from reuse of irrigation water along the Arkansas River. Water at depth is moderately to highly mineralized.
12	Texas-Gulf	Salt water intrusion has caused problems in the Texas City-Galveston-Orange area. Liquid waste disposal is being accomplished by deep injection to saline aquifers, and other wastes are being contained in landfills.
13	Rio Grande	In areas where the valley fill aquifers receive saline water from older rocks and the water evaporates, the ground water quality is poor—often a brine. Locally, carbonate rocks and sandstone in the central and southeastern parts of the region contain highly saline waters.
14	Upper Colorado	Potable ground water occurs in some aquifers, mostly in alluvium, sandstone, volcanics, and some carbonates. Some of the ground water in consolidated rocks is saline. In parts of the Uinta Basin, fluoride exceeds drinking water standards.
15	Lower Colorado	Poor quality ground water occurs along the Virgin River, parts of the lower Colorado River, and the Gila and Salt River Valleys. Excessive fluoride occurs in parts of the region.
16	Great Basin	Deposits of sand and gravel in most of the valley areas in the region contain potable ground water. However, brackish water and brine occur, principally in the Great Salt Lake Basin and major sinks of the Truckee, Carson, Walker Humboldt, and Sevier Rivers and the Black Rock Desert. High concentrations of fluoride and arsenic locally present problems for domestic and municipal use. Irrigation return flows and mine and municipal wastes have caused some degradation of ground water.
17	Pacific Northwest	Local problems include salt water intrusion in coastal areas of Puget Sound, leachates from waste disposal in industrial, urban, and suburban areas, and fertilizer in areas of agriculture. Naturally occurring fluoride, boron, and iron exceed drinking water standards in some locations.
18	California	Nearly a fourth (19 billion gallons per day) of the ground water withdrawn in the United States is taken from the valley areas of California. Most of the supply is of good quality. Along the California coast, only 11 of the 263 ground water areas showed evidence of sea water intrusion, principally near Los Angeles, San Diego, Santa Barbara, and San Francisco. Water quality is poor along the west side of the San Joaquin Valley, around the Salton Sea, and in several

Table 2–6 (continued)

Number	Region	Ground Water Quality
18	California—Continued	sinks in the Mojave Desert. Waste disposal and water reuse are problems.
19	Alaska	Ground water is an untested resource in most of Alaska. Alluvium probably forms the most extensive aquifers in the state and generally contains water of good quality. In the vast area north of the Alaska Range, permafrost is widespread and severely limits ground water use. Excessive iron is a major problem, largely related to glaciation. Saline water underlies much of the Copper River basin. Waste disposal has contaminated supplies locally in the Anchorage area.
20	Hawaii	Most of the fresh ground water in the region is stored below sea level in porous lava flows, much of it floating on saline ground water. Salt water intrusion has occurred in several areas of the Hawaiian Islands and poses a constant threat to ground water supplies. Contamination has resulted locally due to sugarcane mill operations, nitrate derived from fertilizer applications, and waste disposal.
21	Caribbean	In Puerto Rico, ground water supplies nearly 40 percent of total water requirements. In the U.S. Virgin Islands, ground water supplies about 10 percent of needs. Locally, ground water contamination has resulted from domestic, municipal, and industrial waste disposal in landfills and through wells and sink holes, sewage effluent, and saltwater intrusion in several areas along the central, north, and south coasts of Puerto Rico and in small coastal areas of the islands.

Source: Compiled by the U.S. Geological Survey, National Center, Reston, Virginia, taken from U.S. Geological Survey, Professional Paper 813 Series, Water Resources Council, *1975 National Water Assessment*, and U.S. Geological Survey field offices.

a lengthy and difficult process, periodic analysis of samples from any reasonable number of so-called "representative" wells will not accurately "monitor" changes in the quality of the nation's ground water.

Natural Influences

Because ground water moves slowly, on the order of only tens or hundreds of feet per year, it tends to be in equilibrium with the mineral composition of the aquifier. When water first enters the soil in an aquifer recharge area, it generally is low in mineral content. As it moves through the soil and into an aquifer, the ionic content usually becomes progressively more concentrated. As a result, most ground water contains small to moderate amounts of sodium, calcium, potassium, magnesium, bicarbonate, chloride, and sulfate. However, water in some aquifiers, such as the limestone beds, contains moderately high concentrations of calcium and magnesium, the principal cause of "hardness."

Certain minerals in water-bearing rocks cause naturally high concentrations of undesirable substances. Fluoride-bearing rocks can create fluoride concentrations in excess of established drinking-water standards. Natural salt water encroachment from oceans, estuaries, bays, and gulfs causes ground water in many coastal areas to be naturally high in chloride. (Encroachment in some of these areas has been substantially increased by pumping and land development activities.) High concentrations of selenium, cadmium, copper, mercury, zinc, and lead occur locally in ground water in some mining regions of the western United States. Organic compounds also occur naturally in ground water. In some areas, tannin and lignin compounds in earth materials produce highly colored ground water.

Human Disturbances

Although ground water quality may be viewed as good from a nationwide perspective, this is little comfort to those who must rely wholly on ground water and find that their supply is being degraded.

The increasing tempo of the cleanup of lakes and streams is literally driving pollution underground. The past decade has been marked by a phenomenal increase in surface and subsurface disposal and storage of wastes. Not infrequently, waste management has followed a simplistic approach of "out of sight, out of mind." There has not been a general recognition of the cumulative effect upon ground water of leachates from sanitary landfills, sludge storage, highway deicing salt, mine tailings, and industrial waste pits. Also overlooked is the cumulative site-specific effect of seepage from septic tanks, sewage lagoons, countless miles of sewerage systems, and the chemical or biochemical loading of irrigation runoff from intensive agriculture. Because ground water, unlike surface water, moves very slowly, effects tend to accumulate over time. Once contaminated, ground water may remain unusable for hundreds of years, even after the source of the original contamination has been eliminated.

Among the major ground water quality problems in the United States is contamination from surface and subsurface waste disposal and storage—including impoundment or burial of industrial wastes. Toxic substances formerly discharged to rivers or the air are now captured, and must be disposed of somehow. Some are sent to "evaporation" ponds, some are put in drums and buried, and some are injected deep into the earth in wells. All these disposal methods can cause ground water contamination if not carried out properly.

An EPA survey completed in June 1978 has identified more than 133,000 "ponds, pools, lagoons, and pits" used for treatment, storage, or disposal of wastes in the country.[52] More than half of them are used by the petroleum industry for disposal of salt water associated with oil drilling.[53] According to EPA, most such impoundments are unlined, thus allowing wastes and saline water to seep into the ground.[54] Unfortunately, little is known at this point about the impact of these facilities on ground water.[55] Other important sources of ground water pollution are:

- Contamination from agriculture—Infiltration of nitrates, resulting from the application of fertilizer to croplands across the country, is a large nonpoint source of ground water pollution. A similar problem may be developing with the recent introduction of more water-soluble pesticides.
- Seepage from mine tailings and drainage from mines—Surface and subsurface mining operations may cause high concentrations of iron, acid, and sulfate in ground water. For example, more than 1,200 tons per day of acid are discharged from mines in Pennsylvania alone.[56]
- Recharge from septic tanks—Wastes from properly operating septic tanks may have little or no detrimental effect on ground water quality when discharged far enough above the water table, where microbiological degradation of liquid effluents can take place. However, where septic tanks are too close together, or located in rocky or otherwise inappropriate soils or too near the water table, so that natural decomposition is not possible, they can contaminate ground water with bacteria and undesirable substances. Organic chemicals used as septic tank cleaners can also cause substantial contamination of ground water. In western and central parts of Long Island, N.Y., for instance, the upper sand and gravel aquifer that once provided residents with potable water has virtually been abandoned as a water supply source because high concentrations of pollutants from septic systems, industrial sources, and urban runoff have infiltrated the aquifer.[57]

Discharge of hazardous chemicals and waste oil from abandoned mine shaft in Pittston, Pa.

- Pollution from road salt—Application of road salts and seepage from salt storage areas is a regional problem in the northern part of the country. Millions of tons of salts are applied to roads annually, and tenfold increases and more in chloride concentrations of ground water along roads have resulted.[58] Drinking water problems arise as the contaminated water moves away from the roads and reaches nearby wells or streams.

ACTIONS AND PROGRAMS

MUNICIPALITIES

Under the Federal Water Pollution Control Act of 1972 and its further amendments, all municipal sewage treatment plants were to achieve secondary treatment by 1977—with some extensions up to 1983—and they were all to use the "best practicable" waste treatment technology by 1983.[59] In 1979, 7 years into this process, progress has been made. However, the costs of these efforts is a subject of increasing concern, and both Congress and federal agencies are seeking new ways of controlling the expenditures required.

Construction Grants

To assist municipalities in meeting these goals, Congress authorized EPA to obligate $18 billion to municipalities during fiscal years 1973 to 1977 to pay for 75 percent of planning and construction costs for new wastewater treatment facilities.[60] Subsequent public laws, including the Clean Water Act of 1977, have appropriated a total of $28.18 billion in federal grants through fiscal year 1979.[61] Thus, the Construction Grants Program, operating at roughly $4 billion per year, is by far EPA's largest program in terms of direct budgetary outlay.

As of March 1979, EPA had committed $20.7 billion of the $28 billion obligated for the Construction Grants Program, to some 16,000 grants.[62] Only 5,276 of these grants, to which EPA had contributed $1.7 billion in funds, were completed [63] (see Table 2–7). The fact that

Table 2–7

Projects Completed Under Construction Grants Program, March 1979

Type	Number	Amount (in millions)
Step 1 Preliminary Planning	2,257	$155.3
Step 2 Design	1,758	$273.8
Step 3 Construction	1,261	$1,300.0

Source: U.S. Environmental Protection Agency, Office of Water Program Operations, Municipal Construction Grants Division, *Clean Water Fact Sheet*, March 1979, p. 2.

only approximately $1.7 billion of construction projects are complete—with sewage treatment facilities now operating—is a testimony to the long time needed for making the rivers and lakes cleaner.

As of March 1979, EPA had underway 10,582 active grants to which approximately $19 billion was committed (see Table 2–8).

Table 2–8

Active Construction Grants Projects, March 1979

Type	Number	Amount (in millions)
Step 1 Preliminary Planning	5,054	$511.7
Step 2 Design	1,662	$395.3
Step 3 Construction	3,866	$18,000.0

Source: U.S. Environmental Protection Agency, Office of Water Program Operations, Municipal Construction Grants Division, *Clean Water Fact Sheet*, March 1979, p. 2.

To complete the accounting as of March 1979, EPA had an unobligated (uncommitted) balance of approximately $7 billion.[64] This is slightly less than 2 years' worth of annual funding.

For the approximately 16,000 active or completed grants made since 1972, the distribution by community size appears in Table 2–9. Not unexpectedly, EPA has made a large number of small grants to small communities, and a small number of large grants to large cities and metropolitan areas.

Table 2–9

Distribution, by Community Size, of Sewage Treatment Facility Construction Grants, March 1979

Community Population	Percent of Total (by number)	Percent of Total (by dollars)
Under 10,000	66.2	17.9
10,000 to 250,000	28.0	47.0
Over 250,000	5.8	35.1

Source: U.S. Environmental Protection Agency, Office of Water Program Operations, Municipal Construction Grants Division, *Clean Water Fact Sheet*, March 1979, p. 2.

Compliance and Enforcement

The amendments of the 1972 Federal Water Pollution Control Act established July 1, 1977, as the deadline for all publicly owned treatment works (POTWs) to be using secondary treatment and all industrial facilities to be using the "best practical" pollution control technology.[65] EPA has reported that only about 40 percent of the "major" municipal dischargers actually met the conditions of the law on July 1, 1977.[66] Results in industry were better; approximately 80 percent of the "major" dischargers were in compliance by July 1,

1977. EPA considers approximately 3,000 of the 14,500 total municipal dischargers and 4,000 of the 38,000 industrial dischargers to be "major."

Under the enforcement provisions of the Clean Water Act, EPA, as shown in Table 2–10, has brought several hundred actions against municipal and nonmunicipal dischargers in fiscal years 1977 and 1978. The numbers in Table 2–10 show that relatively fewer municipal problems are referred to the Department of Justice.

Table 2–10

EPA Enforcement Actions Under Water Pollution Control Act

Type of Action	1977		1978	
	Non-municipal	Municipal	Non-municipal	Municipal
Administrative Order	354	265	436	556
Referral to the Department of Justice	88	20	107	26

Source: Information supplied by U.S. Environmental Protection Agency, Office of Water Enforcement.

Combined Sewer Overflows

A special problem for many of the nation's older municipalities in meeting the goals set out in the 1972 water pollution legislation is that of combined sewer overflows. Combined sewers are wastewater collection systems designed to transport both sanitary wastes and storm water runoff in the same conduit. Constructing combined sewer systems was accepted practice in densely populated areas until the early part of the 20th century. Combined sewer systems therefore tend to be located in areas of the country that experienced growth from 1850 to 1900.[67]

Combined sewer systems remain a major source of water pollution despite the fact that the wastes they carry may receive treatment most of the time. Problems arise during wet weather, usually following rain, when a combined system may overflow directly to a lake or river. Such overflow points and treatment plant bypasses are necessary design features to prevent damage to the wastewater treatment plant during periods of high flow. However, they can be a major source of pollution because the overflow receives no treatment whatsoever, and because the high velocity of the flow scours the sewer pipes clean of previously settled materials. Combined sewer overflows (CSOs) can also be a source of long-term pollution in the receiving water because discharged solids may settle to the bottom and form sludge deposits. These deposits may continue to deplete the oxygen and cause other problems in the waterway during periods of dry weather.

To learn more about the nation's need for CSO controls to improve water quality, the Congress in the 1977 Clean Water Act required the Administrator of EPA to submit a report on the status of combined sewer overflows in municipal treatment works operations.[68] EPA's report, issued in 1978, found that nationally 38 million people are served by approximately 1,300 combined collection systems.[69] Combined sewer service areas are concentrated in the Northeast, in the upper Midwest, and in the far West. However, 58 major cities in 24 states contain about 81 percent of the total population affected by CSOs. These 58 cities comprise most of the national needs for CSO control.

Recent EPA research emphasizes the importance of controlling CSO pollution.[70] EPA performed two sets of hypothetical calculations in order to determine the relative contribution of pollutants from treated wastes and from bypassed overflows. The calculations were designed to answer the following questions: "If all dry weather sewer flows from areas with combined sewers were to receive secondary treatment as mandated by law, how many million pounds per year of each of five pollutants would be discharged from the treatment plants into natural bodies of water?"; and "For areas with combined sewers, if sewer flows following storm events were automatically bypassed and dumped into natural water bodies, how many million pounds each year of each of five pollutants would be released?"

The results of the calculations, which appear in Table 2–11, show the following:[71]

- Five-day biochemical oxygen demand discharge from the CSO almost equals that from the secondary treatment plant effluent;
- Suspended solids discharge is approximately 15 times greater from CSO than from secondary treatment plant effluent;
- Total nitrogen discharge and phosphate-phosphorus discharge from CSO are each much less than from secondary treatment plant effluent; and

Table 2–11

Estimates of Pollution From Treated Wastes and Untreated Overflows From Combined Sewers in the United States

(average annual discharge in million pounds per year)

Pollutant	Secondary Treatment	Combined Sewer Overflow
BOD_5	344.	306.
SS	344.	5,310.
TN	344.	48.
PO_4	45.8	12.3
Pb	0.457	2.01

Source: CH2M Hill, Inc., *Report to Congress on Control of Combined Sewer Overflow in the United States*, prepared for the U.S. Environmental Protection Agency (Washington, D.C.: U.S. Government Printing Office, 1978) EPA–430/9–78–006, p. 6–11.

- Lead discharge from CSO is approximately four times greater than from secondary treatment plants.

Conventional solutions to CSO problems are expensive. They require building new facilities and implementing regional plans. EPA estimates the cost of controlling CSO sources to be $25.7 billion, not including the estimated cost of storm water control.[72] EPA has already funded approximately $1.02 billion for CSO planning and construction.[73] However, even with state and local contributions to correction efforts taken into account, it is likely that over $19 billion still must be spent federally.

In the report to Congress, EPA presented six possible options for funding CSO correction and recommended adopting the first alternative: "Continue with the Present Law."[74] However, EPA reported that:

> If CSO pollution is to be corrected in a reasonable period of time, states with substantial CSO needs must be willing to spend a large share of their annual [municipal sewage treatment] allocation on CSO projects. Moreover, the relative size of the allocation to these states would be increased if national appropriations were allocated among the states based to a greater degree on CSO needs.[75]

EPA's overall research and development funding for this area should be re-examined in light of other needs. EPA's Office of Research and Development has already invested about $45 million in research and demonstration projects for combined sewer overflow control. Given the magnitude of the presently estimated needs, additional research funds in this area might yield substantial net savings to the public.

Chicago is currently struggling with a combined sewer overflow problem. The combined overflows there cause flows of raw sewage into Lake Michigan, as well as basement flooding in residences. Most of the Chicago area's sewers were built about 1900, and subsequent deterioration of the pipes prevents the system from carrying its design capacity. Thus, a moderately heavy rain storm causes raw sewage to back up into many residences, as well as to flood many streets and underpasses. The sewers of the Metropolitan Sanitary District (MSD) serve the central city and 54 suburban communities, 46 of which have problems with combined sewer overflows. Of these 46 suburbs, 24 have severe basement flooding problems, 16 have minor or moderate problems, and 17 experience street flooding during heavy rains.[76]

The MSD's proposed solution to Chicago's CSO troubles is a system of deep underground tunnels and surface reservoirs. This Tunnel and Reservoir Plan (TARP) was designed to capture storm water and sewage in tunnels or reservoirs and hold it until wastewater treatment plants can handle the flow. Phase I of TARP includes pump stations, drop shafts, collecting structures, and 109.6 miles of tunnels. Phase II provides for an additional 21.5 miles of

tunnels as well as surface reservoirs and increased pump capacity. Total capacity of all storage for Phases I and II would be 44 billion gallons. Phase I will cost almost $2 billion; Phase II will cost $898 million.[77]

The two phases of TARP are not sufficient by themselves to result in much improvement of water quality in Chicago. Associated projects such as construction and expansion of treatment plants, upgrading local sewers, dredging and widening channels, and instream aeration are also necessary. The General Accounting Office (GAO) estimates these associated projects will drive the total cost for TARP to $8.5 billion, making it one of the most expensive public works projects ever.[78]

Not only is TARP expensive, but critics also question how much improvement in water quality will result from its completion. With completion of only Phase I, area waterways would still not meet the lowest Illinois water use standard. Even with both phases completed, area waterways still could not meet the Clean Water Act's national goal of fishable and swimmable waters.[79] There also seems to be some doubt concerning TARP's effectiveness in reducing basement flooding. Phase I will reduce overflows from 100 per year to 10 per year and reduce by 75 percent the amount of raw sewage discharged to waterways.[80] However, TARP would not reduce flooding where collector sewers are inadequate or have deteriorated. Thus many suburban communities will realize no benefit from TARP unless they can find funds to upgrade their local sewer systems that connect with MSD.

A GAO report[81] issued May 17, 1979, is severely critical of the TARP project and estimates that the total cost of all TARP phases and associated projects could exceed $11 billion.[82] GAO's estimate of between $15 and $20 million in annual flood-related damages is much less than the $475 million estimate by the MSD and the Corps of Engineers.[83] TARP will also consume an enormous amount of energy, an estimated 170 million kilowatt hours annually for all phases of the project, enough to supply 27,000 residential customers.[84] Completion of Phase I construction is scheduled for June 1987; Phase II is under study and not yet funded.

GAO recommended that EPA reconsider the TARP project, and adopt more flexible water quality goals that would allow lower water quality standards for some of the waterways affected. GAO also recommended that suburban communities take a series of measures immediately to reduce basement flooding instead of waiting until 1987 or longer before TARP is completed.[85]

EPA has also stated that it agrees with the GAO's recommendation to discontinue any additional funding for TARP.[86] EPA points out that not all of TARP and its associated projects are eligible for federal funding. EPA estimates that slightly more than one-third of Phase I projects are eligible for a 75 percent federal share.

Given the high estimated costs of the TARP project in Chicago, either partially or fully completed, EPA may need to reconsider its

$25.7 billion estimate for nationwide CSO corrections to serve the population in the year 2000.

Needs Survey

How do the commitments and expenditures measure up against total national needs for the control of municipal water pollution? In 1973, 1974, 1976, and again in 1978, in compliance with provisions of the Clean Water Act, EPA has prepared a "Needs Survey Report," designed to define the nation's municipal water pollution control needs and estimate how much it will cost to meet them.[87] EPA estimates it will cost $106.2 billion for construction and repair of municipal wastewater treatment facilities and sewers between 1978 and 2000.[88] An additional $62 billion is needed for control of storm water runoff.

All costs were estimated in January 1978 dollars and do not include the cost of removing toxic pollutants.[89] The 1978 survey results,[90] reported in Table 2–12, are broken down into the following categories:

- I. Secondary Treatment—Costs for facilities that only are required to provide "secondary treatment" or "best practicable wastewater treatment technology" (BPWTT), phrases used synonymously here.
- II. Higher Than Secondary Treatment—Costs for facilities that must achieve treatment levels more stringent than secondary. This requirement generally exists when water quality standards require removal of such pollutants as phosphorus, ammonia, nitrates, or organic and other substances.
- IIIA. Correction of Infiltration/Inflow—Costs for correction of leaky sewer systems.
- IIIB. Major Rehabilitation of Sewers—Costs of extensive repair of existing sewers, when they are collapsing or structurally unsound.
- IVA. New Collector Sewers—Costs of constructing new collector sewer systems and appurtenances designed to correct violations caused by raw sewage discharges and seepage from septic tanks.
- IVB. New Interceptor Sewers—Costs of new interceptor sewers and transmission pumping stations necessary for the bulk transport of wastewaters.
- V. Control of Combined Sewer Overflow—Costs of facilities to prevent and/or control the discharge of untreated wastes from combined sewers.
- VI. Treatment and/or Control of Storm Waters—Costs of treating storm water runoff channeled through sewers and other conveyances used only for such runoff.

These estimates and similar ones prepared by the states may be somewhat high, because they are used to justify funding requests and to allocate funds among states. Mostly, they rest on the assumption that water quality will be protected by the construction of central, expensive wastewater treatment plants. The costs for such a con-

Table 2–12

Estimate of Municipal Needs Between 1978 and 2000 to Comply With Clean Water Act

(January, 1978 dollars)

Needs Category		EPA Assessment (in billions)
I	Plants that require only secondary treatment	15.09
II	Plants that require more stringent treatment than secondary	
	A. To achieve secondary levels	(11.0)
	B. Advanced secondary levels	(6.8)
	C. Advanced treatment levels	(2.7)
	Total category II	20.51
IIIA	Correction of sewer systems infiltration/inflow problems	2.44
IIIB	Replacement and/or rehabilitation of sewers	4.88
IVA	New collector sewers	19.02
IVB	New interceptor sewers	18.47
V	Combined sewer overflows	25.74
VI	Control of storm water	61.67
	Total I, II, IVB	54.07
	Total I–V	106.15
	Total I–VI	167.82

Source: U.S. Environmental Protection Agency, *1978 Needs Survey, Cost Estimates for Construction of Publicly-Owned Wastewater Treatment Facilities* (Washington, D.C.: U.S. General Services Administration, 1979) EPA-430/9-79-001, p. 5.

struction program are so large—on the order of $100 billion—that they raise serious questions of how they can be funded, even over a number of years. At a nominal rate of $4 billion per year, the completion of these projects will take more than 25 years.

Faced with this cost situation, EPA and Congress have been considering ways in which costs can be kept down through modifications of such policies as EPA's building treatment plants, which go beyond secondary treatment of sewage wastes. Also somewhat promising is the potential of using alternative and innovative technologies, such as land treatment, instead of conventional treatment plants.

Treatment More Stringent Than Secondary

Over the years, through both the regular Construction Grants Program and a now terminated demonstration program, EPA has funded a number of municipal treatment works employing "tertiary" or advanced waste treatment (AWT) techniques. Although the 1977 Clean Water Act clearly contains language requiring treatment more stringent than secondary in certain circumstances, Congressional and other critics have charged that EPA has allowed—or even caused—the design and construction of overly expensive and needlessly sophisticated treatment plants. In response to these criticisms, and in compliance with Congressional guidance, EPA has recently announced a new policy to prevent abuses in projects requiring treatment more stringent than secondary.[91]

EPA's policies have evolved as follows. Years ago, EPA defined secondary treatment as that yielding effluent with biochemical oxygen demand (BOD) and suspended solids (SS) of 30 mg/*l* each on a maximum monthly average basis, or that yielding 85 percent removal of these pollutants, whichever was more stringent. In assessing future needs, EPA found that about half of the sewage treatment plants planned for construction or improvement between 1976 and 2000 will meet the conditions of the Clean Water Act if they provide secondary treatment.[92] However, approximately 6,300 of the construction or improvement projects will have to provide treatment more stringent than secondary[93] in order to achieve water quality standards defined under the Act. The 6,300 projects are anticipated to cost approximately $20 billion, with the amount split almost equally between the costs to upgrade from the status quo to secondary equipment and for treatment beyond secondary. Further analyses showed that 1,200 of these projects will be required to meet very stringent levels of treatment.[94]

In May 1979, EPA issued its latest policy to avoid funding systems that are more sophisticated—and more expensive—than needed. In guidance, EPA defined "advanced wastewater treatment" (AWT) to include only systems that provide 50 percent total nitrogen removal and/or that reduce BOD and SS to less than 10 mg/*l* each. The agency also defined "advanced secondary treatment" (AST) as that more stringent than secondary, but less stringent than AWT.[95]

With these new definitions, the agency, through headquarters, regional offices, and states with delegated authority, will conduct rigorous reviews of projects designed for treatment more stringent than secondary in order to determine whether and how much extra treatment is necessary to meet state and federal standards. A project will have to pass this review before it can receive federal funding. The intensity of the review will increase either as the stringency of treatment rises from AST to AWT, or as the incremental cost (above secondary) rises. In abbreviated fashion, here are the easiest and hardest review criteria:

- For AST projects with $1 million or less incremental cost above secondary treatment, the appropriate regional office must determine that seasonal operation has been evaluated, that cheaper land treatment alternatives have been considered fully, that the advanced secondary portions of the project will definitely result in significant water quality improvements and mitigation of public health problems where they exist, and that project costs and local financial impacts meet certain tight conditions.[96]
- For AWT projects with more than $1 million incremental cost, the Administrator of EPA, following reviews by the regional office and headquarters, must review the project and certify that it passes more than 25 tests related to costs, public health, water quality, land treatment alternatives, and local financial impact.[97]

Under this new policy EPA has received 41 AST and 19 AWT projects for review during fiscal year 1979. Although EPA has no official estimate of the expected savings from these $1.9 billion worth of projects, it is thought to be 5 to 10 percent in resource costs.[98]

One of the most important features of this new policy is its special emphasis on land treatment discussed below under "Alternative Treatment Technologies." In all cases of AST or AWT review, a complete analysis of land treatment must be made. Land treatment methods qualify for various special exemptions in the review process.

Past abuses in granting funds for AWT plants are illustrated by the case of Greenville, Maine.[99] EPA granted $3 million in 1973 to construct an AWT plant to serve a sewered population of 1,350. The town was previously unsewered, and malfunctioning septic tanks and direct outfalls were thought to be a potential nutrient problem for scenic Moosehead Lake, adjacent to the town. Greenville's AWT plant relied on complex mechanical and chemical processes to remove nitrogen and phosphorus from the effluent discharge to the lake. The town never formally accepted the plant from the contractor, however, because of severe operational problems and high operation and maintenance costs. The high operation and maintenance costs resulted in sewer bills in excess of $200 per year to residential users and, as a result, many town residents refused to pay their bills.[100]

The plant was abandoned in 1977 after EPA reviewed its performance and costs. Greenville is now suing the plant designer, the filter manufacturer, and those residents who continue to refuse to pay their bills. A land treatment system has been completed, for which EPA will pay 75 percent of the $3.9 million cost.[101] The new land treatment system has low operating costs, including low energy requirements, compared to the previous sophisticated AWT plant.

Alternative and Innovative Technology

The Clean Water Act of 1977, amending the 1972 Act, clearly establishes the intent of Congress to encourage the use of innovative and alternative technology in the Construction Grants Program.[102] There were at least 10 modifications of the law in this regard.

EPA defines alternative waste treatment processes as *proven* methods of wastewater treatment that reclaim or reuse water, recycle constituents, eliminate the discharge of pollutants, or recover energy. Some of the alternative methods for treating both wastewater and sludges in which there is widespread interest are listed in Table 2–13.

EPA has defined innovative wastewater treatment processes and techniques as:

> . . . developed methods which have not been fully proven under the circumstances of their contemplated use and which represent a significant advancement over the state of the art in terms of meeting the national goals of cost reduction, increased

Table 2–13

Alternative Wastewater and Sludge Technology

Effluent Treatment	Sludge Disposal
Land treatment	Land application
Aquifer recharge	Composting prior to land application
Aquaculture *	Drying prior to land application
Silviculture	
Direct reuse (nonpotable)	
Horticulture	
Revegetation of disturbed land	
Containment ponds	
Treatment and storage prior to land application	
Preapplication treatment	

Energy Recovery	Individual and On-Site Systems
Co-disposal of sludge and refuse	On-site treatment
Anaerobic digestion with ≥90% methane	Alternative collection systems for small communities
Self-sustaining incineration	

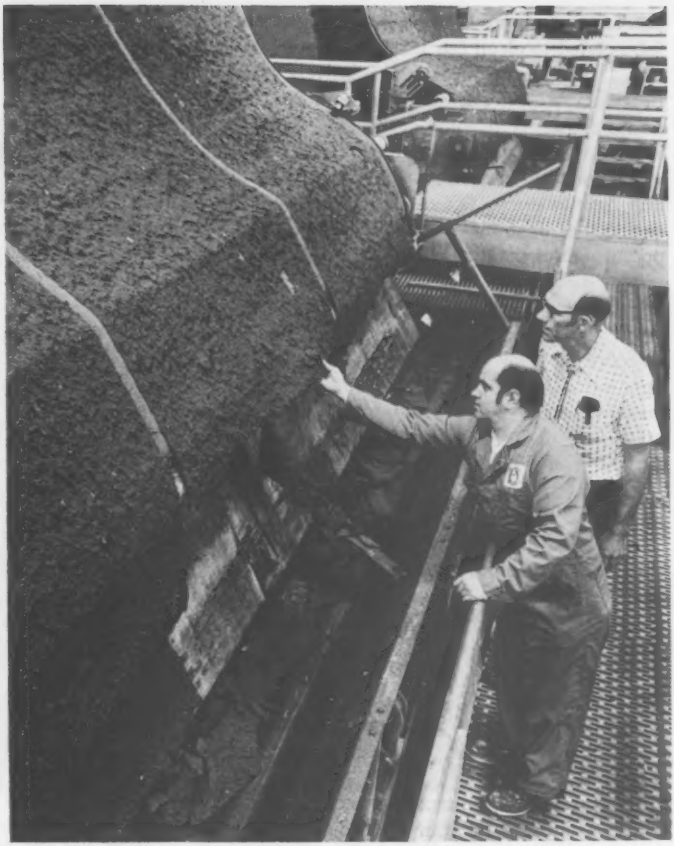
* This includes use of natural and artificial wetlands.

Source: U.S. Environmental Protection Agency, *Innovative and Alternative Technology Assessment Manual*, draft (Washington, D.C.: U.S. Government Printing Office, 1978) EPA–430/9–78–009, p. 2.

energy conservation or recovery, greater recycling and conservation of water resources (including preventing the mixing of pollutants with water), reclamation or reuse of effluents and resources (including increased productivity on arid lands), improved efficiency and/or reliability, the beneficial use of sludges or effluent constituents, better management of toxic materials, or increased environmental benefits.[103]

EPA expects many of the innovative processes to be a subset of the alternative methods described above. Treatment processes based on the conventional concepts of treatment (by means of biological or physical chemical unit processes) and discharge to surface waters will not be considered as "innovative" for purposes of special consideration by the agency unless they meet stringent cost reduction or energy reduction criteria. Specifically, a conventional design will have to show a 15 percent savings in life cycle costs or a 20 percent savings in net primary energy use to qualify as innovative.[104]

The amendments passed by Congress created three economic incentives to encourage alternative and innovative designs. First, they authorize EPA to select preferentially an innovative or alternative process option if the life cycle cost of the treatment works does not exceed the life cycle cost of the most effective other choice by more than 15 percent.[105] Secondly, they allow EPA to fund 85 rather than 75 percent of the cost of any eligible treatment works or significant portion thereof utilizing alternative or innovative techniques.[106] Finally, they authorize EPA to pay 100 percent of all costs to replace



One alternative sludge disposal method is to convert sludge to soil conditioner. Above, sludge destined for composting rolls off vacuum filters of Blue Plains wastewater treatment plant near Washington, D.C. Photographer: Robert C. Bjork.

innovative or alternative treatment facilities if they fail.[107] This "buy back" guarantee was included to help overcome most municipalities' aversion to risk, financial and otherwise.

There are two reasons why the Congress has been so explicit in the law and in its directions to EPA in regard to alternative and innovative technology: environment and economy. Critics, both in the Congress and in the public at large, have argued that conventional collection and treatment systems are a mixed environmental blessing. On the negative side, they point to the urban and suburban sprawl induced by numerous municipal systems. Too often, the installation of far-ranging interceptor sewers feeding a new central treatment plant has allowed or caused rampant, undesirable expansion of urbanized areas. Critics also argue that EPA's heavy emphasis on

secondary techniques and processes just does not or will not do the job needed to clean our lakes and rivers. They say that conventional secondary treatment does a relatively poor job at removing both nutrients (e.g., nitrogen and phosphorus) and toxic substances (e.g., heavy metals and some organic chemicals). Even in areas where secondary treatment could do the job, it sometimes has not done so because treatment plants have recurring problems with operation and maintenance. Too often, plants simply do not function at their design specifications due to scrimping, negligence, lack of repairs, or poor operator training.

In terms of economics, given the high costs of our national needs, any method that will achieve the same or better water quality at a lower life cycle cost will find many friends. Cities and towns should embrace any new technology that will reduce either life cycle costs or operation and maintenance costs. Too many cities and towns have installed conventional treatment plants only to find out that the operations and maintenance costs (in terms of dollars, chemicals, energy, and parts) have sent the local property tax soaring.[108]

Land Treatment

The rebirth of land treatment as an alternative technology, the application of wastewaters to soils, plants, or crops, is an interesting phenomenon.

Land treatment has been an available technology for over 300 years. Berlin, Germany, and Paris, France, have used land treatment since the mid-1800s. Melbourne, Australia, has used it since 1892. Communities like Bakersfield (Calif.), Lubbock (Tex.), Calumet (Mich.), and Lake George (N.Y.), have found it economical and dependable over many decades.[109] However, it has not yet gained wide use.

Land treatment is attractive because all domestic and many industrial wastewaters contain considerable amounts of nitrogen and phosphorus, two nutrients essential for plant growth. Removal of this nitrogen and phosphorus by conventional treatment (either AST or AWT) requires costly equipment, chemicals, and energy. Many land treatment systems use the nitrogen and phosphorus for plant growth and crop production. Land treatment is also attractive because an AWT plant can take about ten times as much energy to produce the same or lesser quality reclaimed water, although the land requirements for land treatment are considerable.[110]

Land treatment projects in two communities, Muskegon, Mich., and El Reno, Okla., show the reality and the promise of crop production as a method of treating wastewater.

Muskegon County (population 160,000) has had complete success with its large-scale demonstration land treatment system. Conceived in the late 1960s and built in the early 1970s, the county-wide system has two sites totalling 11,100 acres.[111] The "renovated" water from the sites passes through a creek and a lake, in each case, before emptying into Lake Michigan a few miles to the west.[112]

Leaf samples from soybeans fertilized with composted sludge are gathered at a test plot near Beltsville, Md., for analysis. Photographer: Robert C. Bjork.

The Muskegon system consists of collection, transmission, aeration, storage, irrigation, soil, crop production, and drainage components. The system currently treats approximately 29 million gallons a day of wastewater, 60 percent of which is industrial flow.[113]

Crop production is the heart of the method. After wastewater arrives at the treatment sites, it is aerated and stored. Then it is pumped to 54 center pivot irrigation rigs via buried pipes for spraying into fields of 35 to 140 acres each.[114] During the winter, all water is stored in artificial lakes for the next growing season.

During 1978, 5,200 of the 5,400 irrigated acres were planted with corn and irrigated with up to 4 inches per week of wastewater. The remaining acres lay fallow or were planted in wheat or rye. Irrigation occurred from mid-May to mid-November with time out for cultivating, planting, and harvesting. Up to 100 inches of water were sprayed on some fields during that time.[115]

Average grain yields in 1976, 1977, and 1978 were about 80 bushels per acre, indeed remarkable considering that the sandy soil would otherwise produce only a few bushels of corn per acre, and that the primary purpose of the system is wastewater treatment. The total crop income has averaged $900,000 during the past 3 years, which offset one-third of the costs of operations and debt retirement for the whole wastewater treatment system.[116] In contribution to that crop, the reuse of nitrogen, phosphorus, and potassium at Muskegon amounted to an average of $280,000 of fertilizer value for each of the past 3 years.[117]

The treatment performance has been spectacular and dependable. Wastewater is purified to the degree shown in Table 2–14. The Muskegon system produces effluent of far better quality than that produced by an AWT plant. Organic material is decomposed by soil microorganisms. Nutrients are absorbed by plants and soil. Suspended matter is filtered out by the soil. Heavy metals, color, and viruses are also removed. Pathogens are destroyed by aeration and in the long retention time in storage. After percolation through the crop-soil filter, the renovated water is collected by an underground tile drainage system and released to natural streams.

Table 2–14

Muskegon County Land Treatment System Resource Removal Efficiency

(1976–1978 averages)

Wastewater Resource	3-Year Average Concentration (mg/liter)		Percent Removal
	Influent	Effluent	
BOD_5	300	3–4	99
Suspended Solids	290	7	98
Phosphorus	3	0.08	97
Nitrogen	9	2.5	72
Potassium	10.5	3	71

Source: Dr. Y. A. Demirjian, Muskegon County Deputy Director of Public Works.

El Reno, a community of 25,000 located approximately 25 miles west of Oklahoma City, has just opened a total water resource project combining elements of drinking water supply, water conservation, land treatment of wastewater, and agricultural production. With the help of a farsighted consulting company, El Reno has taken action to alleviate withdrawal demands on the North Canadian alluvial aquifer and to eliminate an old-fashioned treatment plant in need of costly repairs. When faced with state requirements to upgrade its waste treatment plant and with the prospect of water shortages in the future, the city selected a novel solution.

In essence, El Reno and a local farmer growing crops on 465 acres have entered into a 20-year contract.[118] Under the agreement, the

farmer conveys to the city the use of all ground water rights under the irrigated area. The city uses the water rights to supply drinking water to its residents. The city, in turn, collects all sanitary wastewater, pretreats it, and delivers it back to the farmer in pressure pipelines. The city has furnished, installed, and maintains self-propelled center pivot irrigation sprinklers covering at least 465 acres. El Reno also provides the equipment and the necessary technical expertise to analyze samples and data required for monitoring the land treatment system. The monitoring includes, but is not limited to, measuring the wastewater quality, the ground water quality and direction of flow, and the soil condition, quality, and productivity.[119]

The city and the farmer have agreed to an interlocking set of payments. The city pays for most of the electrical costs for pumping. The farmer conveys his water rights free of charge, and will pay the city a total of $100,000 during the 20-year contract for the nutrients in the water.[120] The contract contains other provisions as well, and other communities following El Reno's example will have to negotiate terms that reflect their unique circumstances.

A few cities and towns have followed Muskegon's and El Reno's lead, but why haven't more? First, land treatment does require con-

This hill in Frostburg, Md., was formerly acid-leaching, eroding strip-mine spoil. Application of composted sludge permitted growth of clover and orchard grass. Photographer: Robert C. Bjork.

siderable open land although neither ownership nor basic land use, if already agricultural or silvicultural, must, of necessity, change. In addition, few engineering consulting firms have persons skilled in designing land-treatment systems.

Finally, there are legitimate environmental and public health concerns that argue for careful attention in the design of any land treatment system. First, ground water can become contaminated with various pollutants. After 6 years of operation, Muskegon has had no such problems but it does monitor 80 wells monthly.[121] Second, critics of some land treatment systems have alleged that bacterial or viral diseases might be spread to nearby residents by aerosols drifting from the sprayers. Muskegon has a monitoring program for this potential problem and has encountered no such trouble. EPA researchers have found no viruses in the aerosols at Muskegon.[122] Third, various toxic substances, such as heavy metals, certain organic compounds, or infectious agents—such as viruses—could become incorporated into the corn and other crops. Again, Muskegon monitors for this problem on a regular basis, and although it has had no problem in this regard, the county sells its corn only as animal feed. This precaution guards against biological hazards, i.e., spread of bacterial and viral disease, but it does not necessarily offer protection against heavy metal or toxic organic compounds.

The accumulation of heavy metals such as cadmium, lead, mercury, and zinc in plants is of particular concern and one that towns with land treatment systems will have to face. Studies [123, 124] have shown that certain plants are better accumulators of heavy metals than others. Lettuce, for instance, accumulates four times the concentration of cadmium as tomatoes when grown on land treated with sewage sludge.[125] Thus the careful choice of crops as well as monitoring for potentially troublesome heavy metal concentrations must be important parts of land treatment. Any municipality employing this technique will have to monitor closely to insure that industrial connectors pretreat to remove heavy metals before discharging into the city's collection system.

On-Site Systems

On-site wastewater treatment systems—methods for treating a household's wastewater on the owner's property—are receiving increased attention these days as potential alternative or innovative technologies. The basic on-site method—the septic tank with soil absorption system—is one of the most common methods for treating household wastes. Problems with septic tanks have received a great deal of public attention in the past 20 years, much of it deserved, as, for example, the extensive contamination of ground water under Long Island. But properly built and maintained septic tanks can work very well. Although sewers and centralized treatment facilities have found widespread use in recent years, they are expensive, particularly for smaller, less populated communities. On-site systems

in general, and septic tank systems in particular, can be an environmentally sound, technically feasible, and less costly alternative method of wastewater disposal in lightly populated areas.

In 1970, about 19.5 million houses—nearly 29 percent of the nation's housing units—used on-site systems to dispose of their wastewater.[126] Each year, about 500,000 new houses are built with on-site systems.[127] Until recently, on-site systems have generally been regarded as only a temporary solution, and are usually replaced by sewers and central treatment facilities. From 1950 to 1970, for example, 10 million houses with on-site systems were converted to sewers and centralized treatment.[128] Usually, these replacements take place after widespread failure of the septic tanks.

A University of Wisconsin study [129] identified the major causes for septic failures as:

- Poor site evaluation;
- Inadequate system design;
- Failure to follow design specifications during construction;
- Inadequate inspection procedures by regulatory agencies; and
- Lack of good operation and maintenance practices.

The last point is especially important. Septic systems often fail simply as a result of human error or neglect. When a septic tank is not periodically cleaned, solids build up and enter the soil absorption field, blocking the flow of effluent into the soil. Maintenance of a septic system requires periodic pumping to remove accumulated solids from the tank. However, where suitable land in sufficient quantity is available, and when properly designed, constructed, and operated, septic systems can function effectively for at least as long as the normal 30- to 40-year life span of central facilities.[130]

The GAO has recently stated that millions of dollars may have been needlessly spent because communities have converted septic systems to sewers and central facilities without adequately considering potentially more cost-effective alternatives.[131] Alternatives such as repairing or replacing individual systems, or a combination of septic systems and limited sewering, are rarely recommended by consulting engineers. The lack of financial incentives, compounded with the belief that septic methods are, at best, temporary solutions, has inhibted consideration of septic-based alternatives. GAO also points out that various federal loan and grant programs have been designed specifically to foster the conversion to centralized collection and treatment.[132]

The GAO study argues for community-managed rather than homeowner-managed septic systems as a viable alternative to sewage treatment plants:

> Effective public management of septic systems in the community could reduce failures and prevent water pollution. Federal, state, and local expenditures for converting septic systems to sewers and central facilities could be significantly reduced.[133]

Public management of decentralized systems is receiving more state and local attention. Two states, California and Washington, have established guidelines that provide localities with the authority to control septic systems. According to the GAO report, public entities must have the essential controls and corresponding authority to do the job properly. Such controls are listed in Table 2–15.

Table 2–15

Recommended State Controls for Individual Sewage Disposal Systems

Control Element	Authority Needed
Siting and design	To enter property and do in-depth site evaluations.
	To set design standards, design septic systems, and review designs.
Installation	To develop inspection criteria, inspect installation, and stop and demand correction of faulty construction.
Operation and maintenance	To enter property to inspect and insure proper operation and maintenance.
Problem correction	To require and enforce repair or replacement of failing systems.

Source: U.S. Comptroller General, *Community-Managed Septic Systems—A Viable Alternative to Sewage Treatment Plants* (Washington, D.C.: U.S. General Accounting Office, 1978) CED–78–168, p. 24.

Although the type of government entity capable of managing a decentralized approach to wastewater treatment would vary from state to state, the promise of environmental and economic benefits is strong enough that other states may follow California's and Washington's leads.

Septic tanks with soil absorption fields are only one type of on-site waste disposal system. Many others exist, one of which—composting toilets with separate greywater disposal systems—bypasses many problems in waste disposal.

A composting toilet uses no water. It therefore eliminates about half of the average household's consumption of water. In doing so, it:

- Saves enormous amounts of drinking quality water;
- Recovers valuable nutrients by transforming them into compost; and
- Eliminates a major source of water pollution because urine, feces, and large amounts of vegetable kitchen scraps never mix with water.

Commercially available dry biological or composting toilets provide an aerated container in which wastes are decomposed naturally by bacteria and other microorganisms. In the composting process, there is a 90 percent volume reduction, leaving behind small amounts of a humus-like residue that can be used as a soil enricher on non-

edible plants. Proper operation, including good aeration, moisture, and a temperature of at least 70° F, is necessary to achieve satisfactory decomposition. Perhaps the best known and most common composting toilet is the Clivus Multrum (trademark), invented in Sweden just after World War II.[134]

The installation and use of a composting toilet does not eliminate the need for treatment of household wastewater. More than one half the water used by a family in a typical household becomes "greywater," the wastewater from the kitchen and bathroom sinks, the shower or bathtub, the laundry, and other sources.

Greywater arises in sufficient quantity and with sufficient pollutional threat that it cannot be ignored. However, the design for a standard septic tank with soil absorption field can readily be scaled down to handle just greywater flows. The use of a composting toilet also opens the way to use of ingenious on-site greywater treatment methods, such as building a family greenhouse with a miniature land-treatment system.

Energy Conservation Technologies

Increased levels of effluent treatment to protect water quality also usually result in increased energy consumption. EPA estimates that publicly owned treatment works (POTWs) used 0.142 quads of energy in 1977 and forecasts an increase to 0.256 quads by 1990. (One quad equals 10^{15} Btus. The United States used approximately 78 quads in 1978.) Although the energy used by POTWs is only 0.17 percent of the national total, high energy costs can add significantly to operating expenses, particularly for smaller communities and communities with AWT facilities.[135] EPA now includes energy efficiency as a factor in the review of applications for federal funds for POTW construction. Proposals for construction of conventional sewage treatment plants that can gain a 20 percent energy saving over similar existing plants may be eligible for 10 percent additional federal funding.[136]

There are many areas with the potential for energy savings in the wastewater treatment process. Methane generated through anaerobic digestion of sludge can be used to power engines or to preheat sludge before digestion. Heat pumps can recover heat from wastewater or exhaust air and then supply space heat for buildings or other processes. Passive and active solar heating systems can provide heat for different treatment processes as well as space heat for buildings. A treatment plant in Wilton, Maine, has incorporated both passive and active solar energy use for heating the building as well as supplying heat for one of the treatment processes.[137]

Since pumps typically account for a major part of the energy consumed in wastewater treatment, the EPA reports that modifications in pump cycling can produce significant savings, particularly for large facilities.[138] Plants that incinerate sludge can incorporate waste-heat recovery systems or other processes to realize large savings in energy usage. As noted, land treatment of sewage can save enormous

amounts of energy, up to 90 percent of the energy required for an AWT plant with similar quality treatment.[139]

POTW Toxic Study

A problem that looms as a serious environmental and cost factor in the future is that of controlling toxic pollutants—substances that are dangerous to human health and aquatic life in very small quantities—at municipal treatment plants. EPA has recently begun a study to develop information that will be used in formulating agency policy on the control of toxic pollutants in publicly owned treatment works (POTWs). The study began in late 1978 and will continue through 1981.[140]

The study undertook sampling and analysis of 129 toxic "priority pollutants," deveoped from a list of 65 classes of toxic pollutants first identified in a 1976 lawsuit by environmental groups against EPA and a subsequent Settlement Agreement,[141] and later in the 1977 amendments to the Clean Water Act.[142] Samples were taken from the sewers of six cities and at the wastewater treatment plants of 40 cities. The toxic substances studied are all:

- Substances for which there is substantial evidence of carcinogenicity, mutagenicity, and/or teratogenicity;
- Substances structurally similar to the aforementioned compounds or for which there is some evidence of carcinogenicity, mutagenicity, or teratogenicity; and
- Substances known to have toxic effects on people or aquatic organisms at sufficiently high concentrations and that are present in industrial effluents.[143]

The 129 chemicals include 13 heavy metals, 114 organic compounds, cyanide, and asbestos.[144]

One of the aims of the EPA study of toxic pollutants in sewage from six cities is to determine how much of the priority pollutants are coming from domestic, commercial, and industrial sources, respectively. The EPA anticipates that the information will be used to determine whether industrial pretreatment programs are working (see "Industries" section below) or whether additional controls for priority pollutants from other than industrial sources should be instituted. Samples are being taken to characterize effluents from old residential areas, new residential areas, shopping centers, and industrial parks.[145]

The objectives of the treatment plant survey of 40 cities are to determine the amounts of the priority pollutants in raw sewage, the plant removal efficiencies for these compounds, and the amounts of each in resulting sludges. The agency will use these data to develop a strategy for the 1983 goals of the Clean Water Act for publicly owned treatment works. The 40 plants were chosen on the basis of size, type of secondary treatment, geographic location, and industrial inputs. Each facility is sampled during a 1-week period, including inflow, outflow, and waste sludges. In addition, some plants are sam-

pled before and after chlorination to determine whether this process forms toxic chlorinated hydrocarbons.[146]

To date, sampling and analysis are complete for three sewage systems and eight municipal wastewater treatment plants. Data are also available from several earlier studies used to develop methodologies for sampling and chemical analysis. Although the results are strictly preliminary, some general observations can be made:

- Nine toxic heavy metals (cadmium, chromium, copper, lead, manganese, mercury, nickel, silver, and zinc) are consistently present in all wastewaters. All 13 metals among the priority pollutants were found in the sludge from a large municipal wastewater treatment plant;[147]
- Six toxic organic chemicals (benzene, chloroform, methylene chloride, bis (2-ethylhexyl) phthalate, tetrachloroethylene, and toluene) are found in nearly all wastewaters including those of domestic origin. Six additional organics are consistently detected (1, 1–dichloroethylene, ethyl-benzene, butyl benzyl phthalate, di-n-butyl phthalate, diethyl phthalate, and trichloroethylene). These materials can be categorized as solvents and plasticizers. The occurrence of additional organics is greater in large municipal facilities with larger industrial inputs. For example, 49 organics were found in the inflow to a large municipal facility, as compared to 33 at a small facility of lower industrial input; and[148]
- Secondary treatment is effective in removing at least 50 percent of the inflowing concentration of most heavy metals. It is difficult to determine actual removals of organic compounds because some are volatile and because all occur at low concentration in the inflow.[149]

Secondary Treatment Modification for Marine POTWs

In June 1979, EPA issued its final regulations[150] for implementing section 301(h) of the Clean Water Act of 1977.[151] This new section of the Act allows municipalities to apply to EPA for modification of secondary treatment requirements for facilities discharging into the ocean, provided some stringent environmental conditions are met. The assumption behind this legislation was that some types of wastes can be far more readily assimilated by the ocean—especially along the West Coast—than they are by rivers and lakes. Thus secondary treatment may not be necessary in all instances of ocean discharge.

Section 301(h) authorizes EPA to modify its secondary treatment requirements (for biochemical oxygen demand, suspended solids, and pH) on a case-by-case basis for POTWs that discharge into deep ocean waters or saline estuarine waters as defined in the act and that demonstrate they comply with eight criteria stated in the Clean Water Act of 1977.[152] These statutory criteria require an applicant to show that its discharge will not impair the physical, chemical, or biological integrity of receiving waters and that it has imposed rigorous controls on the discharge of toxic pollutants. Congress placed a heavy burden upon the applicant to show compliance with these

criteria. Applicants are required to know the composition of their wastes, what industrial and nonindustrial sources are contributing to their wastes, what happens to the wastes after they are discharged, and the impact of their discharge upon water quality and the biota in the coastal zone.[153] The most important resource of the coastal zone is the biota. Their sensitivity and ability to bioaccumulate toxic pollutants were clearly recognized when Congress established the stringent criteria in section 301(h).

Under the new final regulations, a POTW may obtain a modification of the secondary treatment requirements if: (1) it discharged into ocean or saline estuarine waters on December 27, 1977, and (2) it demonstrates, by showing compliance with criteria contained in the regulations, that its modified discharge will not impair the integrity of receiving waters, and that programs will be implemented to control toxic pollutants.[154] The major review criteria center on the following areas:

- There must be an existing state water quality standard applicable to the pollutant(s) for which the modification is requested;
- Applicants must demonstrate that their discharge will not interfere with the attainment or maintenance of the water quality necessary to insure protection of public water supplies; will insure protection and propagation of a balanced indigenous population of shellfish, fish, and wildlife; and will allow recreation activities in and on the water;
- Applicants must submit a monitoring program for conventional and toxic pollutants; and
- Applicants must submit a program for the detailed identification and control of toxic pollutants from industrial and nonindustrial sources.[155]

The final regulations allow applications to be based either on a current discharge or on thoroughly studied and planned outfall or treatment system improvements. However, EPA anticipates that it will be more difficult for applicants to demonstrate the lack of negative effects from an improved discharge based upon predictive judgments than to make such a case from current discharge conditions. Modified permits will not be issued when state or local laws require secondary treatment or when there is a conflict with other applicable federal laws or Executive orders. Also, they will not be granted to facilities currently meeting secondary treatment discharge requirements or for facilities to discharge less than primary effluent or sludge.[156]

In the final regulations, EPA adopted a special policy for native Alaskan villages, U.S. territories, and Puerto Rico to take into account their more limited economic resources and lesser development.[157] EPA will use discretion in scheduling secondary treatment in such communities when toxic wastes are not a problem and when it is determined to be in the interest of providing basic public health protection.[158] Of the more than 200 communities that filed prelimi-

nary applications, 104 were native Alaskan villages and small communities in the U.S. territorial possessions and Puerto Rico.

Public Participation

On February 16, 1979, EPA published final regulations for "Public Participation in Programs under the Resource Conservation and Recovery Act, the Safe Drinking Water Act, and the Clean Water Act," completing a year-long effort.[159] In the process, EPA distributed more than 7,000 sets of concept papers, received more than 300 written comments on the concept papers, conducted public meetings in San Francisco and Washington, D.C., and received 500 more comments on proposed regulations—including 125 received via a special toll-free telephone line. These regulations establish general standards for public participation under the Clean Water Act and set basic requirements for public hearings, public meetings, and advisory groups. The regulations also call for EPA and other agencies to prepare and circulate a "Responsiveness Summary" after an important decision is made. This summary must briefly indicate how the agency decision responds to the public's concerns.[160]

According to the rules for a public hearing,[161] EPA and other state or local agencies holding a hearing under the Clean Water Act, must notify the public via newspaper and mailing lists at least 45 days in advance. It must hold hearings at times and in places which, to the maximum extent feasible, facilitate attendance by the public; it must schedule witnesses in advance, and it must prepare and make available upon request a transcript or complete record of the proceedings. For a less formal public meeting—i.e., any assembly gathering such as a conference, seminar, or workshop—EPA need not require formal presentations, scheduling of speakers, or a record of the proceedings, but at least 30 days notice must be given and anyone wishing to attend must be allowed to do so.

The advisory group provisions[162] are among the most important innovations in these regulations. Under certain conditions, an EPA assistant administrator, a regional administrator, or a state or local official must create an advisory group whose membership must reflect a balance of these interests:

- Private citizens with no financial interest in the action;
- Representatives of public interest groups, who reflect a general civic, social, recreational, environmental or public health perspective and who do not directly reflect the economic interests of its membership;
- Public officials; and
- Citizens or representatives of organizations with substantial economic interests in the plan or project.

In the case of the Construction Grants Program, advisory groups must be established:

- When EPA prepares or requires the preparation of an Environmental Impact Statement during facilities planning;

- When advanced wastewater treatment levels, as defined in EPA guidance, may be required; and
- When a regional administrator determines that more active public participation in decisionmaking is needed because of the possibility of particularly significant effects on matters of citizen concern, as indicated by one or more of the following:
  - —Significant change in land use or impact on environmentally sensitive areas;
  - —Significant increase in the capacity of treatment facilities or interceptors, significant increase in sewered area, or construction of wholly new treatment and conveyance systems;
  - —Substantial total cost to the community or substantial increased cost to users (i.e., cost not reimbursed under the grant);
  - —Significant public controversy;
  - —Significant impact on local population growth or economic growth; and
  - —Substantial opportunity for implementation of alternative or innovative wastewater treatment technologies or systems.

The EPA regulations recognize that primary responsibility for decisionmaking in environmental programs is vested by law in the elected and appointed officials who serve on public bodies and agencies at various levels of government. Advisory groups are intended to assist these officials by making recommendations on important issues. The assisted agency must designate a staff contact person who will be responsible for the day-to-day coordination of the advisory group, and the agency shall require a similar designation—with budget specification—of its contractor. The assisted agency must establish a system to make costs of reasonable out-of-pocket expenses of advisory group participation available to group members. This system may, but need not, provide reimbursement for time away from work. The advisory group may select its own chairperson, adopt rules of order, and schedule and conduct its own meetings. All advisory group meetings must be open to the public, following widespread, advanced public notice.

Under the regulations, EPA can enforce the new public participation requirements through a variety of possible sanctions.

INDUSTRIES

The Federal Water Pollution Control Act of 1972 required EPA to set technology-based effluent control limits for all industries discharging wastes into U.S. waters.[163] Best Practicable Technology (BPT) controls were to be in place by July 1, 1977, and Best Available Technology Economically Achievable (BAT) were to be installed by July 1, 1983.[164] The Clean Water Act of 1977 altered the requirements of the 1972 legislation by extending the 1983 deadline to July 1, 1984, and by establishing three categories of pollutant discharges: conventional, toxic, and nonconventional.[165] BAT would still be required by 1984 for toxic and nonconventional pollutants.

For conventional pollutants, EPA was directed to establish guidelines reflecting Best Conventional Technology (BCT), which would take different cost considerations into account.[166]

Compliance and Enforcement

Every industrial facility that discharges wastes into water must have a permit under the National Pollutant Discharge Elimination System (NPDES).[167] The permits are issued either by EPA, or by states with EPA-approved programs for administering the system. An NPDES permit generally specifies discharge limitations for specific pollutants, establishes schedules for upgrading controls to meet such limits, and requires periodic reports on compliance. As of April 4, 1979, there were 37,845 nonmunicipal NPDES permit holders.[168] There are 32 states or territories with approved programs for administering the NPDES permit system. Pennsylvania and Iowa are the only two additions to the list since June 1978.[169]

Now that the July 1, 1977, BPT deadline has passed, a major part of EPA's effort to clean up the nation's waterways is directed toward insuring compliance with the BPT guidelines. EPA estimates that of the 3,977 major nonmunicipal dischargers, 795 did not meet the BPT deadline.[170] The major nonmunicipal dischargers include 3,703 industrial dischargers, 223 federal facilities, and 51 municipal wastewater treatment plants that are not publicly owned.[171]

EPA has updated its information on compliance with the statutory deadlines several times since July 1, 1977. The latest survey was conducted during April 1979, and revealed that, of the 795 nonmunicipal facilities that failed to achieve BPT standards by the deadline, action had been taken in 648 of the cases.[172] This included 301 civil actions, 96 administrative or consent orders, 25 adjudicatory resolutions, and 31 extension letters. In 175 cases, compliance was achieved without direct formal agency action.

Because of staff limitations, EPA is concentrating its enforcement effort only on "the majors." However, a report prepared by GAO in October 1978 noted that EPA does not define clearly what constitutes a major discharger.[173] In the absence of a clear definition, two EPA regional offices have developed detailed criteria for determining what constitutes a major discharger, but the criteria differ widely between the two regions.[174]

Pollutants from industrial facilities considered minor dischargers can sometimes have devastating effects upon the environment. An example is the pesticide Kepone discharged into the James River at Hopewell, Va., by a small firm operating from a converted gasoline service station.[175] The cumulative effect of the large number of minor dischargers is also unclear. EPA estimates that approximately 80 percent of the pollutants discharged nationally are from major permit holders,[176] but attempts to compare the discharges of major and minor permittees have not conclusively substantiated this claim.[177]

The GAO report found "significant noncompliance with permit conditions, including failure by some industrial facilities to construct

required abatement facilities." [178] GAO also noted that many industrial firms failed to submit the periodic self-monitoring reports required under the NPDES system. Information compiled from EPA's Permit Compliance System (see Table 2–16) indicates the reporting record for various industries ranges from 90 percent in paper and fabricated metals to a low of 54 percent in the steel industry.[179] Failure to submit the self-monitoring reports is a serious problem because it can conceal violations of other permit conditions. Other critics have charged that EPA and the Department of Justice have concentrated their enforcement activities on violations of deadlines and not on violations of NPDES permit conditions, which may be more serious.

Table 2–16

Industry Compliance [a] With Federal Water Pollution Reporting Regulations, 1977 [b]

SIC Code [c]	Industrial Category	Plants in Compliance	Plants Not in Compliance	Plants in Industry, Total	Percent Plants in Compliance
3400	Fabricated metal products	248	18	266	93
2600	Paper products	161	18	179	90
3200	Stone and concrete	89	15	104	86
2000	Food products	375	62	437	86
2200	Textiles	164	28	192	85
2800	Chemical products	480	83	563	85
2911	Petroleum refining	125	25	150	83
1000–1400	Mining	67	14	81	83
2821	Plastic materials	66	14	80	82
3300	Primary metal industries	147	40	187	79
2611, 2621	Pulp and paper mills	175	51	226	77
4911	Electric power plants	293	150	443	66
3312	Steel plants (blast furnaces)	51	44	95	54

[a] Compliance here means that industries report effluent levels to EPA each quarter. It does not necessarily imply that they have reduced their effluents to the limit required by their permit.

[b] Data compiled June 9, 1977 from the Permit Compliance System (PCS) Source Inventory and the *Quarterly Noncompliance Report*.

[c] Standard Industrial Classification Code.

Source: U.S. Environmental Protection Agency, Office of Water Enforcement, *Summary Statistics on Anticipated Violations of the July 1, 1977, Statutory Deadline*, Table 4.

EPA's on-site sampling inspections have shown significant noncompliance by industries. For a 15-month period ending December 31, 1977, EPA regions II and IV conducted 242 sampling inspections of major industrial permittees.[180] Of those, 82 (33 percent) disclosed at least one violation of NPDES permit conditions.[181] The GAO report recommended that EPA expand its on-site sampling inspection coverage by reducing the time spent in some of the individual sampling inspections.[182]

Once EPA has determined that a firm is in violation of permit conditions, it can issue a Notice of Violation (to holders of state-issued NPDES permits, or an Administrative Order (to holders of federal permits) to cease violating permit conditions.[183] The most serious cases can be referred to the Department of Justice for civil or criminal action. During fiscal year 1977, EPA issued 223 Notices of Violation, 619 Administrative Orders, and referred 108 cases to the Department of Justice.[184] The government collected $15,664,865 in penalties and fines as a result of EPA enforcement actions. In fiscal year 1978, an increased effort by the agency to follow up all statutory violations from 1977 produced 992 Administrative Orders, up approximately 50 percent, EPA also issued 291 Notices of Violations, and referred 133 cases to the Department of Justice. For fiscal year 1978, $2,479,793 in penalties and fines were collected, a much lower figure than 1977 because of several large penalties collected in the earlier year.[185]

Conventional Poliutants

EPA defines "conventional" pollutants as: biochemical oxygen-demanding substances (BOD), total suspended solids, fecal coliform bacteria, pH, and oil and grease.[186] These characteristics are typically influenced by wastes discharged from municipal sewage plants, food processing plants, and pulp and paper mills. The Clean Water Act of 1977 requires that EPA review existing BAT limits for conventional pollutants and incorporate any revisions into new BCT standards.[187] The new BCT limitations for pollutants must be at least as stringent as the BPT limits required for the 1977 deadline.[188] However, any additional removal must be subject to a cost test. EPA will compare the cost of BAT levels of pollutant reduction in an industry with costs for removing the same pollutants at a publicly owned treatment works. Specifically, EPA will compare the cost for an industrial source to remove an additional pound of pollutant above the BPT level with the cost for a POTW to remove an additional pound of pollutant above the same level. If the cost to the industry is less than the cost to the POTW, then the additional level of control for the industrial source will be considered reasonable and will be incorporated into the BCT standards.

In August 1978, EPA issued new BCT standards using the cost test, for the industries listed in Table 2–17.[189] Other major industries, listed in Table 2–18, did not require further analysis.

Toxic Pollutants

EPA's toxic pollutant control program is proceeding under a timetable established in settlement of a suit brought by the Natural Resources Defense Council (NRDC) and others.[190] The suit sought to force implementation of the toxic pollutant provisions of the Federal Water Pollution Control Act of 1972. The Settlement Agreement set forth a comprehensive, detailed regulatory program for carrying out the toxic pollutant control and pretreatment objectives of the 1972

law. Specifically, the Settlement Agreement directed EPA to develop effluent guidelines for toxic substances employing Best Available Technology Economically Achievable (BAT) for 21 "primary" industries no later than December 31, 1979. The court also directed EPA to issue water quality criteria for 65 classes of toxic pollutants specified in the agreement (and later in the 1977 amendments to the act), as well as to set new source performance standards and pretreatment standards using BAT guidelines (see Table 2–19 for the 65 classes).[191] EPA and NRDC and the other plaintiffs agreed to a modification to the Settlement Agreement on March 9, 1979, which allows the agency more time to develop the BAT effluent guidelines on the staggered schedule presented in Table 2–20. The modified agreement also allows EPA until December 31, 1979, to publish final water quality criteria for all 65 classes of toxic pollutants.[192]

Table 2–17

Industries for Which New BCT Regulations Were Issued, August 1978

Dairy products processing	
Receiving stations	Fluid mix for ice cream and other frozen desserts
Fluid products	Ice cream, frozen desserts, novelties, and other dairy desserts
Cultured products	Dry milk
Butter	Condensed whey
Cottage cheese and cultured cream cheese	Dry whey
Natural and processed cheese	Condensed milk
Grain mills	
Corn wet milling	Parboiled rice processing
Corn dry milling	Ready-to-eat cereal
Bulgur wheat flour milling	Wheat starch and gluten
Canned and preserved fruits and vegetables processing	
Apple juice	Dehydrated potato products
Apple products	Canned and preserved fruits
Citrus products	Canned and preserved vegetables
Frozen potato products	Canned and miscellaneous specialties
Canned and preserved seafood processing	
Farm raised catfish	Tuna processing
Conventional blue crab	Fish meal processing
Mechanized blue crab	West Coast hand-butchered salmon processing
Nonremote Alaskan crab meat	West Coast mechanized salmon processing
Remote Alaskan crab meat	Non-Alaskan conventional bottom fish
Nonremote Alaskan whole crab and crab section	Non-Alaskan mechanized bottom fish processing
Non-Alaskan scallop processing	Hand-shucked clam processing
	Mechanized clam processing
Remote Alaskan whole crab and crab section	Pacific Coast hand-shucked oyster processing

Table 2–17 (continued)

Canned and preserved seafood processing—Continued	
Dungeness and tanner crab processing in the contiguous states	Atlantic and Gulf Coast hand-shucked oyster processing
Nonremote Alaskan shrimp	Steamed and canned oyster processing
Remote Alaskan shrimp	Sardine processing
Northern shrimp processing in the contiguous states	Non-Alaskan herring fillet processing
Sout hern nonbreaded shrimp processing in t he contiguous states	Abalone processing
Non-Alaskan whole crab and crab section processing	
Breaded shrimp processing in the contiguous states	
Sugar processing	
Beet sugar processing	Liquid cane sugar refining
Crystalline cane sugar refining	
Cement manufacturing	
Leaching	
Feedlots	
Ducks	
Phosphate manufacturing	
Sodium phosphates	
Ferroalloys manufacturing	
Open electric furnaces with wet air pollution control devices	Slag processing
Covered electric furnaces and other smelting operations with wet air pollution control devices	Covered calcium carbide with wet air pollution control devices
	Electrolytic manganese products
	Electrolytic chromium
Electroplating	
Electrolytic chromium	
Glass manufacturing	
Insulation fiberglass	Glass tubing (Danner) manufacturing
Plate glass manufacturing	Television picture tube envelope manufacturing
Float glass manufacturing	Incandescent lamp envelope manufacturing
Automotive glass tempering	Hand pressed and blown glass manufacturing
Automotive glass laminating	
Glass container manufacturing	
Asbestos manufacturing	
Asbestos-cement pipe	Asbestos roofing
Asbestos-cement sheet	Asbestos floor tile
Asbestos paper (starch binder)	Wet dust collection
Asbestos paper (elastomeric binder)	
Meat products	
Simple slaughterhouse	Meat cutter
Complex slaughterhouse	Sausage and luncheon meats processor
Low processing packinghouse	Ham processor
High processing packinghouse	Canned meats processor
Small processor	Renderer

Source: 43 Federal Register 37570 (1978).

Table 2–18

Industries Not Analyzed for New BCT Standards

Grain mills	
Normal wheat flour milling	Animal feed
Normal rice milling	Hot cereal
Cement manufacturing	
Nonleaching	Materials storage piles, runoff
Feedlots	
All subcategories except ducks	
Fertilizer	
Phosphate	Ammonium sulfate production
Ammonia	Mixed and blend fertilizer production
Phosphate manufacturing	
Defluorinated phosphate rock	Defluorinated phosphoric acid
Ferroalloys manufacturing	
Other calcium carbide furnaces	
Glass manufacturing	
Sheet glass manufacturing	Rolled glass manufacturing
Asbestos manufacturing	
Asbestos millboard	Solvent recovery
Coating or finishing of asbestos textiles	Vapor absorption

Source: 43 Federal Register 37570 (1978).

Table 2–19

Classes of Toxic Pollutants for Which EPA Must Issue Water Quality Criteria

1. Acenaphthene
2. Acrolein
3. Acrylonitrile
4. Aldrin/Dieldrin
5. Antimony and compounds
6. Arsenic and compounds
7. Asbestos
8. Benzene
9. Benzidine
10. Beryllium and compounds
11. Cadmium and compounds
12. Carbon tetrachloride
13. Chlordane (technical mixture and metabolites)
14. Chlorinated benzenes (other than dichlorobenzenes)
15. Chlorinated ethanes (including 1,2-dichloroethane, 1,1,1-trichloroethane, and hexachloroethane)
16. Chloroalkyl ethers (chloromethyl, chloroethyl, and mixed ethers)
17. Chlorinated naphthalene
18. Chlorinated phenols (other than those listed elsewhere; includes trichlorophenols and chlorinated cresols)
19. Chloroform
20. 2-Chlorophenol
21. Chromium and compounds
22. Copper and compounds

Table 2–19 (continued)

23. Cyanides
24. DDT and metabolites
25. Dichlorobenzenes (1,2-, 1,3-, and 1,4-dichlorobenzenes)
26. Dichlorobenzidine
27. Dichloroethylenes (1,1- and 1,2-dichloroethylene)
28. 2,4-Dichlorophenol
29. Dichloropropane and dichloropropene
30. 2,4-Dimethylphenol
31. Dinitrotoluene
32. Diphenylhydrazine
33. Endosulfan and metabolites
34. Endrin and metabolites
35. Ethylbenzene
36. Fluoranthene
37. Haloethers (other than those listed elsewhere; includes chlorophenylphenyl esters, bromophenylphenyl ether, bis(dichloroisopropyl) ether, bis(chloroethoxy) methane, and polychlorinated diphenyl ethers)
38. Halomethanes (other than those listed elsewhere; includes methylene chloride, methyl chloride, methyl bromide, bromoform, dichlorobromomethane, trichlorofluoromethane, dichlorodifluoromethane)
39. Heptachlor and metabolites
40. Hexachlorobutadiene
41. Hexachlorocyclohexane (all isomers)
42. Hexachlorocyclopentadiene
43. Isophorone
44. Lead and compounds
45. Mercury and compounds
46. Naphthalene
47. Nickel and compounds
48. Nitrobenzene
49. Nitrophenols (including 2,4-dinitrophenol, dinitrocresol)
50. Nitrosamines
51. Pentachlorophenol
52. Phenol
53. Phthalate esters
54. Polyychlorinated biphenyls (PCBs)
55. Polenuclear aromatic hydrocarbons (including benzanthracenes, benzopyrenes, bnzofluoranthene, chrysenes, dibenzanthracenes, and indenopyrenes)
56. Selenium and compounds
57. Silver and compounds
58. 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)
59. Tetrachloroethylene
60. Thallium and compounds
61. Toluene
62. Toxaphene
63. Trichloroethylene
64. Vinyl chloride
65. Zinc and compounds

Source: *NRDC* v. *Train*, 8 E.R.C. 2120, June 6, 1976.

The effluent guidelines are "technology-based" in that EPA identifies, for each industry, the treatment or control processes that are capable of controlling the toxic pollutants in that industry. EPA then assesses the long-term performance, operational limitations, and reliability of each treatment or control technology. The agency also estimates costs and economic effects associated with the different control methods and compares them with industry-supplied values in order to determine the reasonableness of the costs. Upon consideration of these factors, EPA identifies various control and treatment technologies as BPT, BCT, or BAT. The regulations, however, do not require

Table 2–20

Schedule for Issuance of BAT Guidelines

Industry	Proposal [a] Date	Promulgation [a] Date
Adhesives	2/1/80	8/29/80
Leather tanning and finishing	1/12/79	8/10/79
Soaps and detergents	7/18/80	1/30/81
Aluminum forming	3/21/80	10/17/80
Battery manufacturing	3/28/80	10/24/80
Coil coating	8/14/79	3/21/80
Copper forming	4/11/80	11/7/80
Electroplating	3/21/80	10/17/80
Foundries	10/26/79	5/23/80
Iron and steel	11/2/79	5/30/80
Nonferrous metals	8/24/79	3/21/80
Photographic supplies	2/1/80	8/29/80
Plastics processing	10/10/80	5/8/81
Porcelain enamel	10/12/79	5/9/80
Gum and wood chemicals	8/31/79	3/28/80
Paint and ink	9/21/79	4/18/80
Printing and publishing	11/16/79	6/13/80
Pulp and paper	2/1/80	8/29/80
Textile mills	5/18/79	12/14/79
Timber	5/11/79	12/7/79
Coal mining	12/14/79	6/20/80
Ore mining	11/23/79	7/5/80
Petroleum refining	3/16/79	10/2/79
Steam electric	5/24/79	12/20/79
Organic chemicals	1/11/80	8/18/80
Pesticides	3/21/80	10/17/80
Pharmaceuticals	12/2/79	7/18/80
Plastic and synthetic materials	1/25/80	8/22/80
Rubber	6/23/79	1/12/80
Auto and other laundries	12/7/79	7/4/80
Mechanical products	8/15/80	3/13/81
Electric and electronic components	3/14/80	10/10/80
Explosives manufacturing	12/21/79	7/18/80
Inorganic chemicals	9/21/79	4/18/80

[a] Signature Date

Source: *NRDC v. Costle*, 12 E.R.C. 1833, March 9, 1979.

installation of any particular technology, rather they require the achievement of effluent limitations (expressed in pounds of effluent per 1,000 pounds of raw material) representative of the proper operation of these technologies or equivalent technologies.[193]

Water quality criteria are qualitative or quantitative estimates of the concentration of a water constituent or pollutant in ambient waters that, if not exceeded, will insure a water quality sufficient to permit a specified water use. Under the Clean Water Act, a criterion is a scientific entity, based solely on data and scientific judgment. It does not reflect considerations of economic or technological feasibility. A criterion based on the protection and propagation of fish, for example, is simply the best estimate informed scientists are able to make of the maximum concentration of a given pollutant that can be tolerated while still maintaining protection of fish. Water quality criteria are not water quality standards and in themselves have no

regulatory power. Only if states or EPA adopt water quality criteria values through normal rulemaking procedures can criteria be incorporated into legally sanctioned water quality standards. The significance of a particular criterion value for a specific body of water would also need to be taken into account before criteria could become water quality standards.[194] In March 1979, EPA issued for public comment proposed water quality criteria for the first 27 of the 65 classes of toxic pollutants specified in the Settlement Agreement discussed above.[195] These values (listed in Table 2–21) are proposed values subject to change after the public comment period. The complete list of final values must be published by December 31, 1979.[196]

The modified Settlement Agreement contains an important change regarding EPA's actions for instituting effluent controls more stringent than BAT. Under the revision, EPA will survey navigable waters to determine which waters are "seriously contaminated" by toxic pollutants and identify the sources or causes of the pollutants. The agency will also identify those toxic pollutants that need more stringent controls based upon a survey of "nationwide or other broad geographical basis." This "better than BAT" program then will use two complementary methods (one based on all toxic pollutants and their effect on one waterway; the other on one pollutant and its effect on waters in a broad geographical area) to identify areas and toxic pollutants that need more stringent effluent controls than those established through technology-based BAT limits. The agency is required by the agreement to complete the two surveys by July 1, 1981, and to publish a strategy for reducing or eliminating the identified toxic pollutant discharges by December 31, 1981.[197]

Pretreatment

EPA estimates that at least 87,000 industrial plants classified in the 21 "primary" industries (see Table 2–20) use local sewage treatment facilities to process their wastes instead of using their own treatment facilities to discharge directly into surface waters.[198] Industrial use of publicly owned treatment works (POTWs) can cause serious problems, however. Many industrial wastes are incompatible with normal sewage treatment processes. Toxic substances and heavy metals can accumulate in sewage sludge, be volatilized into the air during aeration, or pass through the plant untreated. They can also interfere with normal treatment operations, resulting in inadequately treated effluent, or damage to the plant equipment. Toxic or heavy metal accumulations in sludge can make the sludge unusable as fertilizer and can result in toxic substances leaching into surface or ground waters if the sludge is placed in a landfill. Toxic materials that pass through the sewage treatment process can result in unacceptably high concentrations in the receiving stream. To prevent these problems, it is necessary for industries with incompatible wastes to pretreat their effluent before discharging into a municipal treatment works, so as to remove most, if not all, the incompatible components.

Table 2–21

Proposed Water Quality Criteria for Toxic Substances

(In micrograms per liter; equivalent to parts per billion)

Substance	Fresh Water Aquatic Life		Salt Water Aquatic Life		Human Health
	24-hour average	Max at one time	24-hour average	Max at one time	
Chloroform	500	1,200	620	1,400	0.21 [a]
2-Chlorophenol	60	180	insufficient data		0.3 [b]
1, 2-Dichlorobenzene	44	99	15	34	230 for all three combined [b]
1, 3-Dichlorobenzene	310	700	22	49	
1, 4-Dichlorobenzene	190	440	15	34	
1, 1-Dichloroethylene	530	1,200	1,700	3,900	0.13 [a]
1, 2-Dichloroethylene	620	1,400	insufficient data		not yet developed
Arsenic	57	130	29	67	0.002 [a]
Benzene	3,100	7,000	920	2,100	1.5 [a]
Beryllium	varies with water hardness		insufficient data		0.0087 [a]
Cadmium	varies with water hardness		1.0	16	10.
Carbon tetrachloride	20	1,400	2,000	4,600	0.26 [a]
Chlordane	0.024	0.36	0.0091	0.18	0.12 [a]
1-Chloronaphthalene	29	67	2.8	6.4	0.08–3.9 for various chloronaphthalenes
2, 4-Dimethyphenol	38	86	insufficient data		not yet developed
2, 4-Dichlorophenol	0.4	110	insufficient data		0.5 [b]
Fluoranthene	250	560	0.30	0.69	200.[b]
Heptachlor	0.0015	0.45	0.0036	0.05	0.023 [a]
Hexachlorobutadiene	insufficient data		insufficient data		0.077 [a]
Hexachlorocyclopentadiene	0.39	7.0	insufficient data		50. [b]
Lead	varies with water hardness		insufficient data		1.0 [b]

N-nitrosadiphenylamine	insufficient data		insufficient data		0.0026 [a]
N-nitrosidiethylamine	insufficient data		insufficient data		0.00092 [a]
N-nitrosodi-n-butylamine	insufficient data		insufficient data		0.0013 [a]
N-nitrosopyrrolidine	insufficient data		insufficient data		0.011 [a]
Pentachlorophenol	6.2	14	3.7	8.5	140.[b]
Selenium	9.7	22	4.4	10	10.[b]
Silver	0.0090	1.9	0.26	0.58	10.[b]
2, 3, 7, 8-Tetrachlordibenzo-P-dioxin	insufficient data		insufficient data		4.55×10^{-9}
Tetrachloroethylene	310	700	79	180	0.20 [a]
Thallium	insufficient data		insufficient data		4.[b]
Trichloroethylene	1,500	3,400	insufficient data		2.1 [a]
Vinyl chloride	insufficient data		insufficient data		51.7 [a]

[a] Level at which 1 additional cancer per 1 million people would be expected.
[b] Level at which no effect on human health is expected.

Source: Compiled from information supplied by U.S. Environmental Protection Agency, Effluent Guidelines Division.

EPA issued a National Pretreatment Strategy on June 26, 1978,[199] that is designed to:

- Prevent inhibition or interference with the operation of municipal treatment works, including contamination of sludge;
- Correct inadequate treatment of many pollutants by industry and by municipal treatment works prior to their release to the environment; and
- Improve opportunities to recycle and reclaim wastewaters and the sludge resulting from wastewater treatment.[200]

EPA is in the process of developing pretreatment regulations for 21 industrial categories.[201] The Settlement Agreement, which controls the timetable of EPA's toxic effluent guidelines, also specifies the schedule for the development of pretreatment guidelines. The March 1979 modification of the Settlement Agreement allows EPA more time to develop pretreatment regulations.[202] The regulations will either limit or prohibit the introduction of incompatible industrial wastes into municipal sewage treatment plants.[203]

Pretreatment is particularly important if the Clean Water Act's goals are to be met. For sewage treatment systems to meet these goals they must employ systems such as land treatment, which usually cannot deal with toxic wastes. EPA requires municipal treatment plants handling more than 5 million gallons of sewage per day to have an approved pretreatment program before complete federal funding will be granted through the EPA Construction Grants Program.[204] EPA will rely heavily on local municipalities to enforce pretreatment limits on industries in their jurisdictions.[205]

NONPOINT SOURCES

Nonpoint source pollution is increasingly recognized as a major challenge in cleaning up the nation's water. Nonpoint sources are those for which there is no one obvious pipe, outfall, or distinct conveyance of pollutants, as contrasted to point sources such as municipal sewage plants and industrial facilities. Nonpoint sources are usually diffuse, difficult to identify, and hard to control. The most important nonpoint sources of pollution are: agricultural activities, urban storm water runoff, mining runoff, silviculture, and individual wastewater disposal systems. As shown in Table 2–22, a majority of the nation's drainage basins are affected by pollution from agriculture and urban runoff. Many basins are affected by other nonpoint sources of pollution as well.[206]

Agriculture

One of the chief sources of nonpoint source water pollution is farming. Water pollution from agriculture is estimated to affect 68 percent of the river basins in the United States.[207] The principal pollutants include pesticides, dissolved solids, nutrients, sediment, organic material, and pathogens. As shown in Table 2–22, the North Central, South Central, Southwest, and Island regions are more ad-

versely affected by agricultural runoff than the rest of the country, though at least 50 percent of the basins in every region are affected. Large quantities of the total pesticides used in the United States (750,000 tons in 1977) and the nutrients employed (49 million tons of commercial fertilizer in 1976) may be applied improperly on cropland. This improper use often contributes to water quality degradation.[208] Rates of erosion are usually greatest from lands improperly managed for intensive production of crops and livestock, a situation that can result in high nonpoint loads to streams, rivers, and lakes near such lands.

Table 2–22

Nonpoint Sources of Pollution

(Percent of basins affected, [a] by type of nonpoint source)

Region (Number of basins)	Urban Runoff	Construction	Hydrologic Modification	Silviculture	Mining	Agriculture	Solid Waste Disposal	Individual Disposal
Northeast (40)	70	15	20	10	20	55	35	63
Southeast (47)	57	2	21	30	15	62	9	40
Great Lakes (41)	54	7	2	15	41	59	15	39
North Central (35)	54	6	3	6	40	89	9	29
South Central (30)	50	0	23	13	53	87	13	40
Southwest (22)	23	0	18	5	36	73	0	35
Northwest (22)	23	23	23	27	23	55	9	32
Islands (9)	67	67	22	0	0	78	22	89
All basins (246)	52	9	15	15	30	68	14	43

[a] In whole or part.

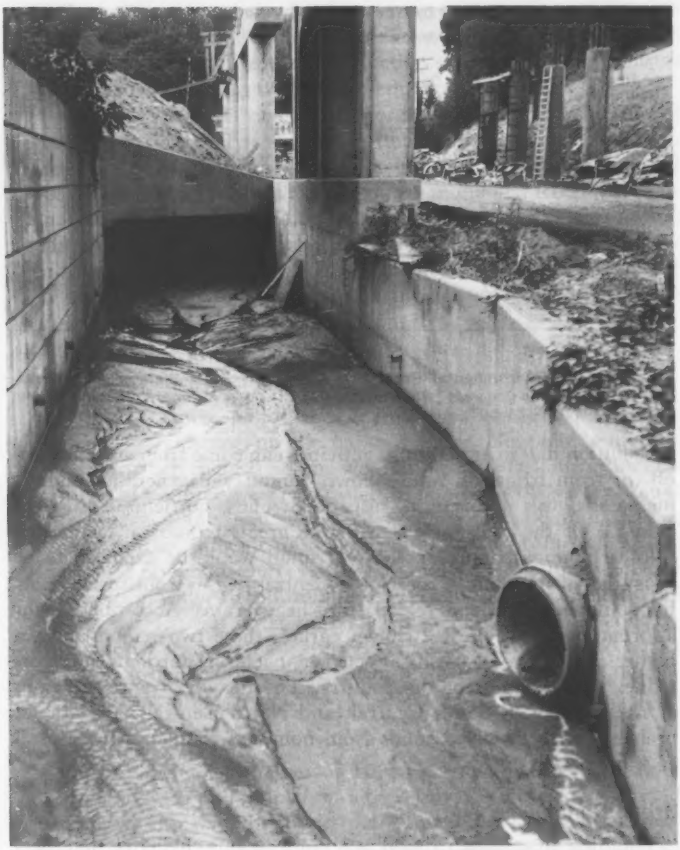
Source: U.S. Environmental Protection Agency, *National Water Quality Inventory, 1977 Report To Congress* (Washington, D.C.: U.S. Government Printing Office, 1978) EPA–440/4–78–001, p. 15.

Pollution due to agricultural activities can come from erosion, runoff, or from irrigation return flows. Runoff will generally result in increased levels of bacteria, suspended solids, nutrients, and pesticides.[209] Of the four regions with the greatest problem from agricultural nonpoint source pollution, runoff would be expected to be a significant problem in the North Central region from spring snow melt and in the Island region from heavy rains. According to the information in Table 2–2 shown earlier, these two regions have a higher percentage of basins affected by bacteria, nutrients, and pesticides than the rest of the country. The heavily irrigated regions of the Southwest, South Central, and North Central have greater problems with dissolved solids from nonpoint sources than the rest of the country.[210]

Urban Runoff

Pollution from urban runoff is a more serious challenge than previously realized. Urban runoff is more severe in the highly metropolitan Northeast region than the rest of the country; however, the

problem is not confined to the Northeast.[211] Urban storm water runoff contains many different pollutants, including heavy metals. Recent studies by the U.S. Geological Survey indicate that urban runoff in Portland, Oreg., contained higher concentrations of settleable solids and coliform bacteria than discharges from a wastewater treatment plant using secondary treatment. [212] A study of the Occoquan watershed in northern Virginia determined that concentrations of lead, zinc, and copper in urban storm water were highest in commercial districts, due to a large area of impervious cover and large concentrations of motor vehicles.[213] The Occoquan study also determined that storm water runoff from the nearby small urban basins contains many times the amount of metals than does wastewater from households in the area.[214]



Runoff from construction areas is often laden with sediment and other pollutants, as shown above. Photographer: E. F. Sauer.

Stream Bank Protection

Activities in the near vicinity of streams and rivers have a special importance to water quality. Preservation of the natural vegetation along the edges of streams can help control degradation of water quality from two causes: debris and sediment transported by runoff, and the dislodging, shifting, or slumping of significant portions of the stream bank.

Natural vegetation on a stream's borders is able to filter debris and sediment transported by runoff. The root structures of mature vegetation can bind soil strata so that damaging geological impacts to watercourses do not occur; in addition, canopies of trees and shrubs can shade water bodies and protect against thermal pollution. If activities in areas within 100 feet of watercourses are planned and executed to keep vegetative disturbance to a minimum, degradation can be greatly reduced. In forestry, a selective uneven-aged management cutting method along watercourses can preserve mature trees, taking advantage of the support provided by them to soil strata of the stream bank.

EPA's 208 Program

EPA's main program to deal with nonpoint source pollution is the Water Quality Planning and Management Program created by Section 208 of the Clean Water Act.[215] So called "208 plans" or "WQM plans" are prepared by regional planning agencies or states to identify and propose solutions to the water quality problems in their area. These plans address both point and nonpoint sources of pollution in surface and ground water, while other facets of the 208 program, such as the Nationwide Urban Runoff Program,[216] deal specifically with nonpoint problems. As of July 2, 1979, 129 plans out of a projected 226 plans have been certified by state governors and 75 have been approved by EPA (see Table 2–23). EPA expects all plans to be submitted, approved, and certified by October 1979.[217]

Table 2–23

Status of 208 Plans, July 2, 1979

Region	State/Area	Certified	Approved
I	Greater Portland	×	×
	Southern Maine	×	×
	Northern Maine	×	×
	Androscoggin	×	×
	Southern Kennebec	×	×
	Rhode Island	×	×
	Vermont	× Partial	
	Southeastern Massachusetts	× Partial	
	Old Colony	×	
	Martha's Vineyard	×	
II	Tri County, New Jersey	×	×
	Middlesex County	×	
	Nassau-Suffolk	×	
	Mercer County	×	

Table 2–23 (continued)

Region	State/Area	Certified	Approved
III	New Castle County	X	X
	Baltimore	X	X
	Roanoke	X	X
	Rappahannock	X	X
	Washington, D.C., COG	X Partial	
IV	Central Midlands	X	
	Alabama	X Partial	
	First TN-VA	X	
	Charleston	X	
	Tennessee	X	
	Waccamaw, S.C.	X	
	West Alabama	X	X
	Orlando, Florida	X	X
	Volusia County	X	X
	Tampa Bay	X	X
	Tallahassee	X	X
	Central Florida	X	X
	Georgia	X	
	Southwest Florida	X	
	Macon-Bibb County	X	X
	Chatham County	X	X
	Atlanta	X	X
	Kentuckiana	X	X
	Raleigh, North Carolina	X	X
	Memphis	X	X
	Knoxville	X	X
	South Carolina	X Partial	X Partial
	Mississippi	X Partial	
	Mid Cumberland	X	
	Chattanooga	X	
	Appalachian	X	
	Low Country	X	
	Florida	X	
	Brevard	X	
	Palm Beach	X	
	Pensacola	X	
	Broward	X	
	Dade County	X	
	Detroit	X	X
	So. Cen. Michigan	X	X
	Flint, Michigan	X	X
	Jackson, Michigan	X	X
	East Central, Michigan	X	X
	West Mich. Shoreline	X	X
	Grand Rapids	X	X
	Lansing	X	X
	East Upper Peninsula	X	X
	Northwest Michigan	X	X
	Northeast	X	X
	West Upper Peninsula	X	X
	Southwestern Michigan	X	X
	Central Upper Peninsula	X	X
	Cincinnati	X	X
	Toledo	X	X
	Eastgate	X	X
	Miami Valley	X	
VI	Oklahoma	X	
	Central Texas	X	
	New Mexico	X	X
	Indian Nations	X	X
	North Central Texas	X	
	Southeast Texas	X	

Table 2–23 (continued)

Region	State/Area	Certifed	Approved
VI	Houston	X	
	Alamo Area	X	
	Coastal Bend	X	
	Lower Rio Grande	X	
	Texas	X	X
	Arkansas	X	
	Arkhoma	X	
VII	Des Moines	X	X
	Iowa	X Partial	X
	Kansas	X	
	Mid-America	X	
	East-West Gateway	X	
VIII	Pikes Peak	X	X
	Pueblo, Colorado	X	X
	Denver	X	X
	Larimer-Weld	X	X
	South Dakota	X	
	Sixth District, South Dakota	X	
	Southeastern South Dakota	X	
	Provo, Utah	X	X
	Salt Lake County	X	X
	Weber River	X	X
	Uintah Basin	X	
IX	Pima, Arizona	X	X
	Central Arizona	X	X
	District 4, Yuma, Arizona	X	X
	Southeastern Arizona	X	X
	Ventura County	X	X
	Monterey Bay	X	X
	San Diego	X	X
	San Francisco Bay	X	X
	Washoe, Nevada	X	X
	Clark County, Nevada	X	X
	Northern Arizona	X	X
	Nevada	X	X
	Hawaii	X	X
	Sacramento	X	
	California	X	
	Phoenix	X	
	Los Angeles	X	X
	Tahoe	X	X
	Carson River	X	
	Trust Territory	X	
	Guam	X	
X	Oregon	X	
	Portland	X	X
	Mid-Willamette	X	X
	Lane COG	X	X
	Rogue Valley	X	X
	Washington	X Partial	
	Clark County	X	X
	Metro Seattle	X	X
	Snohomish	X	X
	Total Certified:	129	
	Total Approved:		75

Source: U.S. Environmental Protection Agency, Office of Water Program Operations.

On May 23, 1979, EPA issued final regulations governing the 208 planning process.[218] The new rules are designed to promote implementation of the plans, involve the states in a defined role in the planning process, and insure greater integration and consolidation among EPA environmental programs.[219] To insure implementation of completed 208 plans, EPA will not continue to fund any 208 agencies after fiscal year 1979 unless a significant portion of the plan is being implemented.[220] A state's activities will be clearly defined in state/EPA agreements that will integrate planning, management, and implementation of programs under the Clean Water Act, the Resource Conservation and Recovery Act, and the Safe Drinking Water Act.[221]

EPA's oversight of 208 programs has been criticized for failure to require comprehensive planning by the areawide agencies. A GAO report issued in December 1978 criticized the short time allowed by EPA and the Clean Water Act for 208 agencies to complete their plans, and the subsequent tendency of most plans to address only the easily identifiable sources of pollution.[222] The GAO also pointed out that a lack of cause and effect data about the benefits of pollutant control measures may hinder implementation of the plans and even result in legal challenges to implementation. Land management techniques to reduce nonpoint source pollution will be controversial and will therefore require strong support in terms of adequate data.[223]

In the past, 208 planning has suffered from the fact that previous administrations made it a low priority. Fund impoundments kept the program from getting off the ground for some time. EPA has made major changes in the program's direction in an attempt to turn the 208 program around.[224] A staff report for the House Subcommittee on Housing and Urban Development and Independent Agencies initially recommended that all funding for 208 planning be discontinued for fiscal year 1980 because of the large backlog of unused funds.[225] EPA now states, however, that all funds appropriated for fiscal year 1979 will be committed by the end of that year and that to cut off funding for 1980 would waste money already spent developing such programs as the Nationwide Urban Runoff Program.[226] In August 1979, a Congressional Conference Committee agreed on a $37.5 million budget for the 208 program in fiscal year 1980.[227]

Despite its problems, the 208 planning process remains important to developing rational integrated solutions to complex water quality problems. To abandon water quality planning would be to risk piecemeal, inefficient solutions to cleaning up the nation's water, and to abolish virtually the only mechanism the nation has for dealing with its very serious nonpoint source pollution problems.

Nationwide Urban Runoff Program

The Nationwide Urban Runoff Program is an assessment and evaluation effort administered by EPA. It has selected 30 urban

areas in which data will be collected to assess urban nonpoint source problems and evaluate the effects of these sources on receiving water quality. The program will also evaluate Best Management Practices (BMPs), which could be used to control the pollution from urban runoff. The total cost will be $30 million through fiscal year 1981, with $6 million already committed in fiscal year 1979.[228]

Rural Clean Water Program

The Clean Water Act of 1977 authorized the Department of Agriculture, with the concurrence of EPA, to implement a program to apply and maintain BMPs on rural lands to control agricultural nonpoint source pollution. The Clean Water Act of 1977 authorized $200 million to be appropriated for fiscal year 1979 and $400 million for fiscal year 1980.[229] Funds were to be used for contracts of 5 to 10 years with land owners to maintain the BMPs.

Unfortunately, the Rural Clean Water Program was stalled during the 95th Congress. The authorized funds were not appropriated. House and Senate conferees deleted all funds last year because of disagreements over program administration.[230] The President's fiscal year 1980 budget asked for $75 million, which would allow 20 to 40 projects of approximately 100,000 acres each to be initiated.

EPA is presently working with the Department of Agriculture, as well as with state and local agencies, in the Model Implementation Program (MIP) to help fill the gap in agricultural BMPs until the Rural Clean Water Program becomes fully operational. The program is working on assisting farmers and ranchers in implementing BMPs in critical water quality areas, developing information on benefits and costs, and studying the effects of BMPs on stream quality. Seven agricultural areas were selected in fiscal year 1978 for the MIP program.[231]

Related Programs

Beyond these efforts, several other federal programs are being redirected to place emphasis on improving water quality by controlling nonpoint sources. Two examples from within the Department of Agriculture are illustrative:

- The Science and Education Administration/Agricultural Research Office has underway the development of a predictive water quality model. That model will be used to predict and evaluate the effectiveness of BMPs applied to the land; and
- The Agricultural Stabilization and Conservation Service (ASCS), using funds appropriated for the Agricultural Conservation Program (ACP), has approved 21 water quality projects in 21 states. Under this program the ASCS recently announced assistance to an EPA research project in Tama County, Iowa. EPA already has 3 years of data in this project area and will identify BMPs to be tested there.

DRINKING WATER

The Safe Drinking Water Act (SDWA), passed in 1974 and amended in 1977,[232] requires EPA to establish federal standards for drinking water, protect underground sources of drinking water, and establish a joint federal-state system for assuring compliance with the resultant regulations.

EPA's National Interim Primary Drinking Water Regulations became effective on June 24, 1977.[233] Table 2–24 lists those contaminants for which maximum allowable levels have been set. Initial monitoring for water quality was to have been completed within 1 year for those supplies whose raw water was derived from a surface source such as a river, lake, or reservoir. Communities using ground water supplies are to have initial monitoring completed within 2 years. Results of the initial monitoring suggest 10 to 20 percent of the nation's water supply systems, mainly very small systems, do not meet existing standards.[234]

Table 2–24

National Interim Primary Drinking Water Standards

Constituent	Maximum Concentration (in mg// unless specified)
Inorganic chemicals	0.05
Arsenic	0.05
Barium	1
Cadmium	0.010
Chromium	0.05
Lead	0.05
Mercury	0.002
Nitrate (as N)	10
Selenium	0.01
Silver	0.05
Fluoride	1.4–2.4
Organic chemicals turbidity	1 tu up to 5 tu
Coliform bacteria	1/100 ml (mean)
Endrin	0.002
Lindane	0.004
Methoxychlor	0.1
Toxaphene	0.005
2,4D	0.1
2,4,5 TP Silvex	0.01
Radionuclides	
Radium 226 and 228 (combined)	5pCi//
Gross alpha particle activity	15pCi//
Gross beta particle activity	4 mrem /year

Source: U.S. Environmental Protection Agency, Office of Drinking Water.

State Primacy

SDWA envisions that the states will exercise primary enforcement responsibility (primacy) for drinking water programs, with EPA assuming this task only when a state is unable or unwilling to meet minimum requirements contained in the regulations.[235] In order to attain primacy under the act, a state must establish drinking water

standards and procedures for variances and exemptions at least as stringent as the national regulations; adopt and implement an adequate enforcement program; maintain records and submit reports as required by the Administrator; and establish an emergency response plan and a program for plan review.

As of July 1979, 41 states had been granted primacy by EPA (see Table 2–25). Six other states are expected to be granted primacy in the immediate future.[236]

Sources of Drinking Water

Most U.S. citizens drink water from large publicly owned systems drawing on surface water supplies (Figure 2–18).[237] However, the

Table 2–25

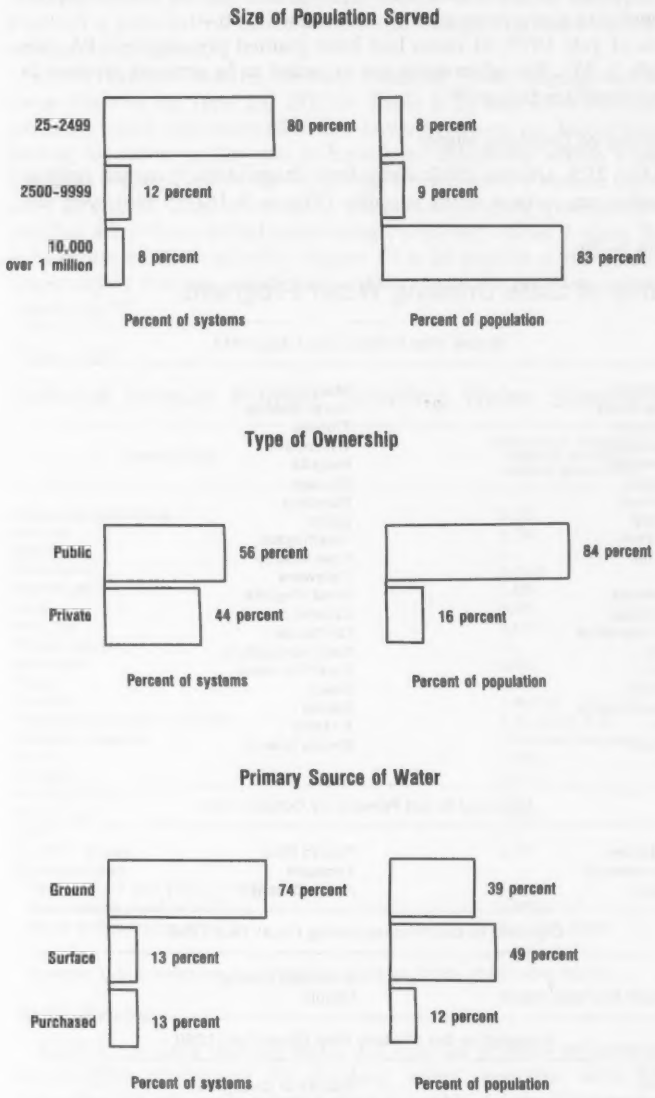
Status of State Drinking Water Programs

States With Primacy as of July 1979	
Oklahoma	Maryland
Connecticut	North Dakota
Louisiana	Florida
Mississippi	Wisconsin
Nebraska	Nevada
Alabama	Kansas
Arkansas	Montana
Georgia	Idaho
New York	Washington
Virginia	New Mexico
Iowa	Delaware
Minnesota	West Virginia
Tennessee	Colorado
South Carolina	California
Maine	New Hampshire
Hawaii	Trust Territory
Kentucky	Guam
Massachusetts	Alaska
Texas	Arizona
Michigan	Rhode Island
Ohio	
Expected to Get Primacy by October 1979	
New Jersey	Puerto Rico
Virgin Islands	Vermont
Missouri	North Carolina
Expected to Get Primacy during Fiscal Year 1980	
Utah	American Samoa
Northern Mariana Island	Illinois
Expected to Get Primacy after Fiscal Year 1980	
Indiana	District of Columbia
Pennsylvania	South Dakota
Oregon	Wyoming

Source: U.S. Environmental Protection Agency, Office of Drinking Water.

Figure 2–18

National Profile of Community Water Supply Systems



Source: Temple, Barker and Sloane, Inc., submitted to the U.S. Environmental Protection Agency, *Survey of Operating and Financial Characteristics of Community Water Systems* (Washington, D.C.: Government Printing Office, 1977).

greatest number of public water supply systems in our country are ground water systems, even though a minority of citizens use them. Significantly, while large communities are able to operate and maintain water supply facilities properly, small communities often cannot. Therefore, ground water, filtered and covered by several layers of earth, has traditionally been considered the best source of water for small communities. However, as discussed earlier, contamination of ground water has become a significant drinking water problem in some areas.

Underground Injection Control (UIC) Program

EPA has reproposed regulations aimed at controlling one source of contamination of underground water: injection of liquids, including liquid toxic substances, into or near underground water-bearing strata. First proposed on August 31, 1976, the regulations were the subject of intense public comment and controversy.[238] The reproposal is based on new data and extensive reanalysis, especially concerning oil and gas production.

EPA has developed a regulatory scheme for protection of underground water supplies that closely parallels its hazardous waste regulations. All operators of specified types of injection wells will be required to have permits.[239] Mechanical integrity, defined as the absence of significant leaks and unwanted fluid migration into underground sources of drinking water, will have to be demonstrated as a condition for obtaining a permit and every 5 years thereafter for the life of the well. Should the technical construction, operation, and maintenance requirements prove insufficient to insure the safety of underground sources of drinking water in a particular instance, additional requirements, including the proper abandonment of a well, may be imposed.[240]

Because injection into an underground stratum creates additional pressure in the receiving formation that may force undesirable fluids into underground sources of drinking water through nearby abandoned or producing wells, a calculated or a fixed zone of such endangerment will be subjected to review.[241]

The Congress clearly intends that the states lead in implementing the UIC program as well as the overall drinking water program. Part C of the SDWA requires EPA to establish minimum requirements for effective state implementation programs. EPA must also list states in need of a UIC program. On September 25, 1978, EPA published a list of the 22 states containing approximately 85 percent of the injection wells to be regulated, asking them to develop UIC programs. Forty states have now been listed, and EPA intends to list the remaining states and territories by mid-1980. Each program must meet or exceed federal requirements. EPA may approve a state's program in whole or in part, but if a state fails to develop an approvable program, EPA must implement a UIC program for it. To encourage state leadership, federal grants are provided for program development and continued operation.

Trihalomethanes

Trihalomethanes (THMs) are some of the synthetic organic substances that are created by chlorination of water that contains naturally occurring organic material. THMs are also used in some industrial applications as solvents and can therefore be found in water because of industrial waste disposal. Several THMs are carcinogenic in animals and may be toxic at extremely low concentrations. Community water supplies usually chlorinate to disinfect their water against bacterial and viral contamination, but it is this chlorination that reacts with natural fulvic and humic material in the water to form chloroform, dichlorobromomethane, and other THMs.[242]

On February 9, 1978, under the Safe Drinking Water Act,[243] EPA proposed amendments to the Interim Primary Drinking Water Regulations[244] designed to deal with the problems of THMs in public drinking water. The proposed amendments set a maximum contaminant level of 0.10 mg/*l* for total trihalomethanes (TTHMs). These regulations would apply to all community water systems serving over 75,000 population. Communities between 10,000 and 75,000 population would be required to monitor for THMs for 1 year. Systems serving fewer than 10,000 would not be required to monitor.[245]

A second part of EPA's proposed regulation requires the use of granular activated carbon (GAC) filters to protect against synthetic organic contaminants. Community water systems serving greater than 75,000 people would be required to install GAC filtration. Those systems drawing water from protected water supplies will be exempt.[246]

GAC filtration is not widely used in the United States, and those 40 systems that do use GAC filtration do so to improve taste and odor of the water, not to remove synthetic organic chemicals.[247] GAC, in fact, does not remove THMs themselves, but binds the natural organic substances that react with chlorine in the water treatment process to form THMs. GAC treatment has been used extensively in Europe, but under somewhat different conditions than exist with U.S. waters. European systems do not draw directly from surface water supplies, but pump water from wells along river banks. The water is filtered naturally through the river bank, which removes up to 40 percent of the organic material before it reaches the GAC filter.[248] EPA's proposed regulations do allow for variances from the GAC requirement, if a community's source water is free from synthetic organic contaminants, or if another treatment method can be proven to be as effective as GAC filtration,[249] such as bank filtration followed by European methods.

The proposed amendments to the Interim Primary Drinking Water Regulations have created much controversy, particularly the requirement for only one treatment technique, GAC filtration. The American Water Works Association (AWWA) protested that no water system now uses GAC treatment that would satisfy the design criteria of the proposed regulation.[250] On the other hand, the Environmental Defense Fund (EDF) noted that by confining the GAC requirement

to cities of population over 75,000, only 52 percent of the U.S. population would be protected. The EDF advocates expanding the GAC requirement,[251] while AWWA advocates its dismissal.[252]

The cost of installing GAC treatment in the 61 to 78 systems that come under the proposed regulations is also part of the controversy, EPA's estimate of the average cost added to monthly consumer bills is $10 to $20.[253] Capital costs nationally have been variously estimated to be as low as $615 million and as high as $5 billion.[254]

EPA's proposed amendments to the Interim Primary Drinking Water Regulations for THMs and GAC have prompted much comment and the agency is assessing the need for changes before promulgating the final regulations.

Coordination with the Clean Water Act

EPA has undertaken a major study to coordinate the provisions of the Safe Drinking Water Act and the Clean Water Act.[255] SDWA requires the Administrator to submit a report to Congress on the present and future availability of an adequate and dependable drinking-water supply.[256] CWA requires the agency to recommend legislation to Congress that would require coordination between water supply and wastewater control plans when municipalities build federally funded municipal treatment works. Because an assessment of drinking water availability and demand must be prepared as part of the wastewater treatment study, EPA decided to combine the two reports.

The study will discuss the following major issues: ground water depletion, inadequate water supplies, water reuse, water management, in-stream and off-stream uses, conservation, water consumptive treatment technology, institutions, and coordinated planning.

Looking Ahead

In the next few years, the nation will have to address three basic and difficult problems concerning safety of drinking water:

- Carcinogens in source and finished water—There is continuing debate on how best to eliminate carcinogenic contaminants in water, air, and food. Several such compounds have been identified in sources of drinking water, and even more have been identified in finished waters leaving drinking water treatment plants.
- Aging distribution systems—The pipes in the water supply distribution systems of many large East Coast cities are old. It has been suggested that there may be large scale interruptions of water supply due to breakdowns in the future. The estimated costs for preventive action are large, perhaps as high as $50 to $100 billion nationwide.[257] Other preliminary reviews indicate that the cause of distribution system failure may not be so much the age of the pipes as it is the inadequacy of maintenance of other urban infrastructures such as roads.[258] Potholes alone cause extreme pressure on underground pipes as traffic travels the roadways.

- Drinking water supply in water starved areas—Much of the West experiences water shortages. Traditionally, all consumer-related water has flowed through the same pipes, thereby requiring all water used in the home to be of drinking water quality. However, much of this water need not be potable. Dual water systems allowing the reuse of treated water for certain activities may become not only desirable but necessary. Of course, duplication of water systems could also be tremendously expensive.

OCEAN DUMPING

The world's oceans have come under increasing ecologic pressure from ocean disposal of ordinary and toxic municipal and industrial wastes. To reverse this trend, a group of nations negotiated the Convention on Prevention of Marine Pollution by Dumping of Wastes and Other Matters (Ocean Dumping Convention) in London in November 1972, and the treaty came into force in 1975.[259] By mid-1979, it had been ratified by 27 nations, including the United States, and 12 others had acceded to it.

In response to the international agreement and to ever more pressing domestic waste disposal problems, the U.S. Congress passed the Marine Protection Research and Sanctuaries Act of 1972.[260] Its purpose is to prevent or limit strictly the ocean dumping of any material that would adversely affect human health, welfare, or amenities, or the marine environment, ecological system, or economic potentialities. In practical terms, the act is intended to stop all "harmful. . . . dumping" by 1981; the critical phrase "harmful dumping" is defined as the dumping of wastes that do not meet certain environmental impact criteria.[261] The law directs the EPA and the U.S. Army Corps of Engineers (subject to EPA review) to administer permit systems to control dumping in ocean waters. The permit systems now cover all materials transported for dumping including sewage sludge, industrial wastes, radioactive wastes, wastes to be incinerated at sea, and dredged material disposal.[262]

Vast amounts of materials are disposed of under the permit systems, mostly off the East Coast, as Table 2–26 shows. For every year since 1973, when the permit system began, the Atlantic Ocean has accounted for more than 90 percent of the total national disposal, and the Pacific Ocean for almost none at all. In the 6 years from 1973 to 1978, ocean dumping dropped from about 10.9 million tons to 8.3 million tons—a 24 percent decrease. The decline would have been even greater were it not for two special events in 1978: a major industrial strike and the upgrading of certain large municipal sewage treatment plants, which led to the need to dump more sewage sludge.

In fact, municipal sewage sludge disposal has increased between 1973 and 1978, while industrial waste dumping has dropped by about 50 percent. Paradoxically, the rise in sewage sludge dumping is directly related to the national water cleanup effort. The Clean Water Act of 1972 (as amended) requires mandatory secondary

Though the tonnage has declined since 1973, a number of east coast cities still practice ocean dumping of wastes. Photographer: Gary E. Miller.

Table 2–26

Types and Amounts of Ocean Disposal by Geographic Area, 1973–78

(in approximate tons)

Waste Type	1973	1974	1975	1976	1977	1978
Atlantic						
Industrial waste	3,642,800	3,642,000	3,322,300	2,633,200	1,783,600	[a] 2,548,000
Sewage sludge	4,898,000	5,010,000	5,039,600	5,270,900	5,134,000	[b] 5,535,000
Construction and demolition debris	973,700	770,400	395,900	314,600	379,000	241,000
Solid waste	0	0	0	0	100	0
Explosives	0	0	0	0	0	0
Incinerated (wood)	10,800	15,800	6,200	8,700	15,100	18,000
Incinerated (chemicals)	0	0	0	0	0	0
Total	9,526,200	9,438,200	8,764,000	8,227,400	7,311,700	8,342,000
Gulf						
Industrial waste	1,408,000	937,700	119,600	100,300	60,200	173
Sewage sludge	0	0	0	0	0	0
Construction and demolition debris	0	0	0	0	0	0
Solid waste	0	0	0	0	0	0
Explosives	0	0	0	0	0	0
Incinerated (wood)	0	0	0	0	0	0
Incinerated (chemicals)	0	12,300	4,100	0	17,600	0
Total	1,408,000	950,000	123,700	100,300	77,800	173

	Pacific					
Industrial waste	0	0	0	0	0	0
Sewage sludge	0	0	0	0	0	0
Construction and demolition debris	0	0	0	0	0	0
Solid waste	240	200	0	0	0	0
Explosives	0	0	0	0	0	0
Incinerated (wood)	0	0	0	0	0	0
Incinerated (chemicals)	0	0	0	0	12,100	0
Total	240	200	0	0	12,100	0

[a] Increase in industrial waste over last year due to an extended strike at NL Industries during 1976–77 during which time the plant was completely shut down.
[b] Increase in sewage sludge primarily due to the upgrading of sewage treatment plants to secondary treatment in New York City, Middlesex County, and Joint Meeting.

Source: U.S. Environmental Protection Agency.

treatment for all municipal wastewaters in an effort to "restore and maintain the chemical, physical, and biological integrity of our Nation's waters".[263] Secondary treatment necessarily creates more sewage sludge needing disposal, and the cities and towns of the Atlantic Coast have turned increasingly to ocean disposal. In 1977, faced with the rising trend in ocean disposal of municipal sewage sludge, the Congress amended the Marine Protection, Research, and Sanctuaries Act of 1972 (Ocean Dumping Act) to require the cessation of all such dumping by December 31, 1981.[264]

Although the intent of the law is unmistakably clear, the difficulties of complying will be great. During the next 2 years, EPA's implementation and enforcement of various provisions of the Resource Conservation and Recovery Act, the Clean Water Act, and the Clean Air Act may create strong pressures to increase ocean disposal of certain wastes. In addition, it is difficult to see how New York City and other major metropolitan areas can completely modify their present practices to eliminate the dumping of primary and secondary sludges by the end of 1981, especially given the poor fiscal health of some of the older coastal cities.

A major new method for the safe disposal of certain highly toxic organic compounds has appeared in the last year or two. Incineration at sea [265] holds the promise of becoming a major alternative to land-based incineration or dumping into ocean waters. This disposal technique uses vessels that have been specially designed and equipped with on-board incinerators. The motor tanker *MT Vulcanus,* owned by Ocean Combustion Services of the Netherlands, for example, has special cargo tanks and high-temperature (over 1250° C) incinerators. After loading hazardous or toxic liquid combustible wastes at port, it steams offshore to a permitted point for the burn.

During tests, the incinerators have oxidized organochlorine wastes, resulting in emissions primarily consisting of water, carbon doxide, and hydrogen chloride. These gases are discharged directly to the atmosphere without scrubbing. Perhaps the most impressive use of this innovative technology was the virtually total combustion of 2 million gallons of herbicide Agent Orange, a notoriously toxic and persistent organochlorine compound, at a site 800 miles west of Hawaii. Monitoring indicated that the combustion efficiencies and destruction efficiencies of the herbicide were more than 99.99 percent and that there were no adverse effects on the personnel or the environment. The tests to date have been so successful that a U.S. incinerator ship will be built and the feasibility of ocean platform incineration is being studied.

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262. U.S. Environmental Protection Agency, *Ocean Dumping in the United States, Sixth Annual Report of the Environmental Protection Agency on Administration of Title I, Marine Protection, Research, and Sanctuaries Act of 1972, as amended, January-December 1977* (Washington, D.C.: U.S. Government Printing Office, 1978), pp. 13–15.
263. Clean Water Act, *supra* note 38, 33 U.S.C.A. 1251(a).
264. 33 U.S.C.A. 1412(a).
265. U.S. Environmental Protection Agency, *Ocean Dumping, supra* note 262 at 37.

CHAPTER 3

TOXIC SUBSTANCES AND ENVIRONMENTAL HEALTH

In the late 1970s, the world's roster of environmental disasters had a new addition: Love Canal. Waste chemicals dumped decades earlier into this abandoned, built-over waterway escaped into the air, water, and soil of Niagara Falls, N.Y., with visible and alarming effects on the health of residents. In August 1978, President Carter declared Love Canal an emergency, the first time in U.S. history that emergency status had been conferred on a human-caused situation.

The Love Canal disaster drew a large government response. By early 1979, local, state, and federal agencies had spent more than $27 million helping families move, and sealing and draining the waste dump. But Love Canal was only a part of the story. Other dangerous chemical waste dumps had also been discovered across the nation. The extent of the problem has yet to be measured adequately. A report to the U.S. Environmental Protection Agency (EPA) in February 1979 estimated that there may be 32,000 to 50,000 disposal sites in the United States containing hazardous wastes, and of these, anywhere from 1,200 to 2,000 may pose significant risks to human health or the environment. Most of these dumps are still being used; perhaps 500 to 800 are abandoned.

In June 1979, the Carter Administration proposed to Congress a $1.6 billion fund to help clean up chemical waste sites like Love Canal and to respond to chemical and oil spill emergencies. There were already laws on the books to prevent dangerous dumping of hazardous wastes in the future and to control many other aspects of the use of toxic substances. The federal Resource Conservation and Recovery Act of 1976 (RCRA) provides for government control over hazardous wastes from their point of generation to final disposal. EPA is in the process of issuing regulations to carry out this comprehensive hazardous wastes law.

Overall, more than two dozen major federal laws exercise control over toxic substances in various forms and places: from pesticides to foods, from the workplace to the nation's air and water.[1] In addition, there are a number of laws affecting nuclear materials. The broadest of these laws is the Toxic Substances Control Act of 1976 (TSCA). This complex law, now in the early stages of implementation by EPA, authorizes the federal government to collect

information on chemicals that may damage human health or the environment and to control them where necessary. The scope of the law is extensive. More than 4 million chemicals have been registered with the American Chemical Society since 1965, and EPA lists more than 43,000 chemical substances in an initial inventory of chemicals in commerce subject to TSCA (which does not include pesticides, drugs, tobacco products, and certain others). One of the most significant features of TSCA is the authority it gives the government to screen chemicals before they reach the marketplace.

There were continuing discoveries in the past year of serious health problems apparently linked to chemicals or other toxic substances in the environment. In an unprecedented action, EPA used emergency powers to suspend most uses of two widely used herbicides—2,4,5-T and Silvex. Traces of dioxin, a deadly poison and carcinogen, were found in residues of both herbicides. EPA's action was based in part on evidence of an abnormal number of miscarriages in women living near Oregon forests sprayed with 2,4,5-T, which supplemented animal data showing a range of reproductive effects.

There were reports of nerve damage and other illnesses in Vietnam veterans who had been exposed to the defoliant Agent Orange, a crude mixture of 2,4,5-T and another chemical, also containing the dioxin residue. And high death rates from cancer were reported among residents of Nevada, Arizona, and Utah who had lived near the Nevada site of nuclear testing in the 1950s and 1960s. Radiation levels after the tests were not monitored or recorded, so actual exposure levels are not known, but the link between radiation and cancer is well established. In fact, radiation is one of the few causes of cancer that has been positively identified by human evidence.

As this chapter discusses, it is difficult to identify environmental causes of cancer by human evidence alone. Animal tests are essential for identifying carcinogens (at least in the present state of scientific understanding) and scientists generally consider them valid. There is some public misunderstanding about animal tests for cancer, which perhaps has arisen because people assume that any substance will cause cancer if enough of it is given. However, the majority of substances tested, even at high doses, do not cause cancer. It appears that substances either cause cancer or they do not. The reasons for giving large doses in animal tests are explained below and have to do with cost, convenience, and inherent differences between the infinite variety of human beings and homogeneous strains of laboratory animals. In the highly technological age of the late 20th century, it is essential to obtain data on the multitude of physical and chemical agents continually entering our environment, and determine which of these may cause cancer, birth defects, or other grave harm to human beings or serious damage to the natural environment. The protection offered by TSCA and other major laws controlling toxic substances will not be realized unless the substances suspected of causing damage to human beings and the environment are adequately tested.

This chapter summarizes the major events of the year, present, and future risks from toxic substances, and what actions are being taken to protect people and the natural environment from those risks.

HAZARDOUS WASTES

THE PROBLEM

In August 1978, the N.Y. State Department of Health officially termed the Love Canal area of Niagara Falls, N.Y. "a grave and imminent peril" to the health of those living nearby.[2] Investigating residents' complaints of abnormal numbers of miscarriages, birth defects, cancer, and a variety of other illnesses,[3] the N.Y. State Department of Health found that hazardous chemical wastes had leaked from rotted drums buried in the old Love Canal into the basements of nearby homes and into the area's air, water, and soil. At least 82 different chemical compounds were identified, 11 of them actual or suspected carcinogens. Air monitoring equipment identified pollution levels ranging as high as 5,000 times the maximum safe levels.

The houses lining Love Canal have been sold to the state, boarded up, and abandoned since the discovery that hazardous chemicals from an old dump were threatening the health of residents.

Love Canal, an uncompleted, abandoned 19th century waterway, had been used as an industrial dump site since the 1930s; it was purchased in 1947 by the Hooker Chemical and Plastics Company. In 1953, after uncounted thousands of drums of toxic chemical wastes and residues had been buried, the site was covered and sold to the Niagara Falls Board of Education for $1.00. The board constructed an elementary school and a playing field on the site. Part of the site was sold to a developer who built several hundred homes on the periphery of the old canal.

Chemicals had appeared sporadically on the surface of the canal for years. In 1976, after 6 years of unusually heavy rains and snow, the chemicals began seeping into basements. Rain had filled the canal and was prevented by the canal's clay bed and banks from percolating deeper. The canal overflowed. Chemicals that had leaked from the now decayed drums entered the environment.

In August 1978, Dr. Robert P. Whalen, N.Y. State Health Commissioner, recommended that pregnant women and children under 2 years of age, residing in the Love Canal area be evacuated. Dr. Whalen reported no evidence of acute illness at the site but said there was "growing evidence . . . of subacute and chronic health hazards as well as spontaneous abortions and congenital malformations." [4] Thirty-seven families were immediately evacuated, their homes boarded up, the school closed, and the site enclosed by a barbed-wire fence. Concurrently, President Carter declared Love Canal a disaster area, which made federal disaster relief aid available to the residents through the Federal Disaster Assistance Administration.

The health, economic, social, and legal costs of Love Canal will not be totaled for many years, but as of July 1979:

- Two hundred and sixty-three families had been evacuated; two hundred and thirty-six homes had been purchased by the state; a thousand additional families had been advised to leave their homes;
- Housing values had dropped to nil;
- Almost $27 million had been appropriated by municipal, state, and federal agencies for providing temporary housing, closing off the contaminated area, and containing the leachate (including digging a trench, installing a drain pipe to catch the leachate, and covering the canal with a clay cap to seal it) ; and
- Nine hundred notices of claims had been filed against Niagara Falls, Niagara County, and the Board of Education for a total of more than $3 billion in damages to health and property, and other suits had been filed against Hooker Chemical Company.[5]

As investigators sought to measure the scope and seriousness of the Love Canal problem, their findings raised new concerns. One of the wastes in the Love Canal leachate, trichlorophenol, contains dioxin, a chemical that animal tests have shown to be 100 times as deadly as strychnine. Some forms of dioxin have been found to be carcino-

genic, and the chemical has been associated with other significant long-term toxic effects.[6] Investigators report there may be as much as 500 pounds of dioxin buried in Niagara County.[7]

Moreover, it seemed that Love Canal had not been Hooker Chemical's only dump. The company had disposed of greater quantities of toxic materials in several other locations in Niagara County—under another school field, near a stream that flows past drinking water wells, and at a site only a few hundred feet from the Niagara Falls municipal water treatment facility.[8]

Hazardous wastes were found in other areas around the country as well—sometimes surfacing after years of burial to pollute drinking water systems, sometimes clandestinely dumped along roadsides or into storm sewers or in open lagoons, sometimes injected into wells thousands of feet into the earth. For example:

One million gallons of toxic waste were stored at the dumpsite in Lowell, Mass.

- In Lowell, Mass., 1 million gallons of mixed toxic waste stored in 15,000 rotting drums and tanks was discovered at a closed waste dump only one-quarter of a mile from inhabited homes. Among the wastes were flammable solvents, chlorinated hydrocarbons, plating and etching wastes, and solvent distillation residue sludges. Local pollution of soils, ground water, and air had resulted from spills and leaks of the wastes. Earlier, while the dumpsite was still active, improper discharges of untreated materials into sewers, causing backups 1 mile away, had caused health problems for sewer workers and led to complaints by workers in neighboring firms. The waste dump operator, the Silresim Company, had since gone bankrupt, leaving the chemical dump behind. Massachusetts was forced to appropriate $1.5 million to remove the wastes.[9]
- In Gray, Maine, trichloroethane, which is classified as a carcinogen by the National Cancer Institute, was found in the ground water aquifer under the East Gray section of the town, apparently due to storage and operations by an oil tank cleaning firm, the McKin Company. The company was closed down by the city in September 1977, but 16 polluted wells had to be sealed, and for some time 750 families were forced to rely on trucked water. Since then, the town has had to extend the municipal water system to affected areas, at a cost to the taxpayer of $600,000.[10]
- In Hardeman County, Tenn., 40 families near a rural land-fill drank from wells polluted with such pesticides as endrin, dieldrin, aldrin, and heptachlor. The Velsicol Chemical Company had used a neighboring 300-acre site from 1964 to 1972 for shallow burial of 300,000 55-gallon drums of pesticide production residues. Residents have complained of a wide variety of ailments including liver and urinary tract problems, dizziness, nausea, and rashes. They have filed a $2.5 billion suit against Velsicol; meanwhile, they have had to hook into the water system of nearby Toone, Tenn., at a cost of $200,000.[11]
- Near Montague, Mich., toxic wastes disposal from another Hooker Chemical Company plant have polluted surface and ground waters. The wastes include mirex (a pesticide), chloroform, carbon tetrachloride, and other chlorinated hydrocarbons. A contaminated plume 2,000 feet wide extends 1 mile from the disposal site to White Lake, a major recreational finger lake of Lake Michigan. Onsite disposal of drums containing toxic wastes and lagoon disposal of brine sludges ceased in 1978, but the site is still used for deep-well injection of brines. The state has sued Hooker Chemical to force cleanup of the site, a job estimated to cost between $200 and $300 million.[12]

Hazardous waste dumps are not the only cause for concern—there is also the problem of transporting toxic chemicals and wastes around the country. In 1978, there was a rise in casualties from toxic transportation accidents, with 45 deaths and 1,411 injuries nationally. Major accidents in 1978 involved sodium sulfhydrate, anhydrous ammo-

nia, chlorine liquor, liquefied petroleum gas, and fuel oil. The worst accidents were in Waverly, Tenn., where a Louisville and Nashville Railroad train derailed and tank cars filled with liquefied petroleum gas blew up, killing 15 and injuring 48; in Youngstown, Fla., where a tank car carrying chlorine gas was punctured in a derailment, resulting in 8 deaths and 158 injuries; and in Chicago, where a tank truck containing sodium sulfhydrate was mistakenly unloaded into a storage tank containing chrome liquor, and the mixture of the chemicals resulted in the release of hydrogen sulfide gas, killing 8 and injuring 30.[13]

Cleanup of old dump sites, response to spills, and proper disposal of hazardous wastes generated in the future are major environmental challenges. Certain basic questions need to be answered to develop a rational policy to control the problems. For example: How much hazardous material is discarded? How fast are the wastes accumu-

A train carrying chlorine, anhydrous ammonia, carbon tetrachloride, and other dangerous chemicals burns after derailment near Crestview, Fla.

lating? How many dumps presently exist? How many of them are leaching? How fast are the wastes spreading underground? Answers to many of the questions will be especially difficult to obtain as they involve difficult policy judgments rather than the simple compilation of facts. For example: What exactly is a hazardous waste? What is acceptable disposal? Who is responsible for paying to clean up abandoned waste sites? How much will it all cost?

Existing estimates on the extent of the problem vary so widely they are only marginally helpful. Once implementation of RCRA begins, more reliable information should become available. Meanwhile in mid-1979 these were the facts, estimates, and "best guesses" that the federal government had on hazardous wastes:

What are hazardous wastes? The traditional definition of hazardous wastes has included salts, acids, bases, or inorganic toxic metals (such as mercury and arsenic); flammables (such as solvents); synthetic organic chemicals (such as pesticides and phenols); explosives (such as methane); infectious materials (such as hospital wastes); and radioactive wastes (such as uranium mill tailings).[14] Once a waste is classified as hazardous by EPA, it has to meet standards for safe disposal that may be costly. The problem for EPA is to define levels of hazard that are both manageable and protective of the health and the environment.

How much hazardous waste is generated? EPA estimates that 10 to 15 percent of the 344 million metric wet tons of industrial waste produced each year is hazardous, yielding approximately 51 million tons. Such waste is estimated to be growing at a rate of 3 percent per year.[15] The amount of waste currently in dump sites cannot be calculated.

How many disposal sites are there, where are they, who owns them, and how many pose a threat to human health or the environment? This is one of the major unknowns. In February 1979, an EPA-contracted study by Fred C. Hart Associates came up with "ballpark estimates" showing that the number of waste sites that may contain hazardous wastes ranged from 32,000 to 50,000. Of those, the number that may pose significant problems to health and the environment were estimated in the range of 1,200 to 2,000.[16] Hazardous dumps probably exist in every state, but the precise locations are not always known. Dump sites are owned by municipalities, by waste generators, and by private disposal operators.

What is required for safe disposal? This is another difficult question. Disposal methods generally used in the past have now been shown to be grossly inadequate. EPA has proposed technical regulations governing all hazardous waste landfills (see detailed discussion below), including lining the site, monitoring it, and posting financial coverage. Future technological innovation may make reprocessing, incineration, and other processes more efficient and safe means of disposal.

How much waste has been disposed of properly? This question is difficult to answer because of the difficulty in defining hazardous

waste. EPA estimates that only about 10 percent of hazardous wastes are being disposed of in a manner that would comply with regulations that the agency expects to adopt. The vast majority of toxic wastes (80 percent by weight) is being disposed of in nonsecure ponds, lagoons, or landfills. Another 10 percent is being incinerated in a manner that pollutes the air or does not completely detoxify the waste residues.[17]

In cases of improper disposal, how far have toxic materials traveled? This is another problem that is difficult to track. Movement of waste varies with the nature of the waste, soil conditions, weather, and method of containment. In some places, wastes have seemed to remain fairly static. Elsewhere they have moved as rapidly as 2 feet per day.[18] Contamination of ground water is an exceptionally serious problem, as it is the water supply for half the U.S. population and its use is growing rapidly.[19] Even after pollution is abated, ground water requires an extremely long time to cleanse itself, often remaining contaminated for more than a century. When the U.S. Geological Survey tested a 39-year-old, 17-acre landfill at Islip, N.Y., it found the leachate plume extended a mile from the site, was 1,300 feet wide and 170 feet deep. The leachate had fouled about 1 *billion* gallons of ground water (enough water to supply Washington, D.C., with all its water for a week).[20]

How much will it cost to dispose of all hazardous wastes properly once RCRA is implemented? The estimates vary widely. After studying the 17 industries that would be most affected—including electroplating, organic and inorganic chemicals, textiles, petroleum, rubber, and plastics—EPA reported that collectively they spend approximately $155 million per year for hazardous waste management. According to EPA, proper management in accordance with proposed regulations would raise that figure to $750 million annually (or one-quarter of 1 percent of the value of production—$267 billion—of the 17 industries).[21] Industry sources disagreed with EPA, pointing to a survey by the Manufacturing Chemists Association of 63 member companies. The survey reported only 1 of 475 industry surface impoundments containing hazardous wastes would meet the new disposal criteria proposed by EPA. Preliminary estimates by the association indicate an expenditure of nearly $900 million to bring those impoundments into line—and many industries weren't tabulated in the survey.[22]

How much will it cost to clean up abandoned hazardous waste dumps? In 1978 the problem of cleaning up abandoned and inactive dumps was handled on an ad hoc basis, with costs absorbed by local, state, or federal agencies, depending upon circumstances. For instance, the Love Canal costs were shared by the Federal Disaster Assistance Administration, EPA, New York, and Niagara Falls.[23] In Tennessee and Maine, part of the costs of extending municipal water supply systems to substitute for the polluted wells was paid for by the towns and part by the Department of Housing and Urban Development. In some cases the responsible company has contributed

Forty families drank from wells polluted with pesticide residues in the Valley of the Drums, Hardeman County, Tenn.

to costs. No public agency has enough money to clean up all the inactive dumps, costs that have been estimated at $28.4 billion to as much as $55 billion.[24]

THE RESOURCE CONSERVATION AND RECOVERY ACT OF 1976

The Resource Conservation and Recovery Act, passed in 1976, is the government's primary tool for controlling hazardous wastes and protecting the public's health from their effects.[25] Once fully implemented (a process expected to take 5 to 10 years), RCRA will provide cradle-to-grave control of hazardous waste.

Before the Act's passage, most regulatory powers were vested with the individual states, whose solid waste departments were generally underfunded and undermanned. Information gathering and enforce-

ment ranged from haphazard to nil.[26] Now, under RCRA, each state must run a hazardous waste program that meets at least the minimum requirements set forth by EPA, or give control over hazardous wastes to EPA.

Subtitle C of RCRA, covering hazardous wastes, establishes a regulatory process that controls the dangerous wastes from the moment of their creation to their final disposal in an environmentally safe manner. The Act's key provisions call for the development of criteria for identifying hazardous wastes (such as level of toxicity); the creation of a manifest system to tag wastes and track them through final disposal; and the organization of a permit system based on performance and management standards for hazardous waste treatment, storage, and disposal.[27]

All individuals and industries generating waste will be required to check EPA standards to determine whether their waste is hazardous. If it is, they must complete a manifest containing basic information about the waste before it is shipped off to a licensed treatment, storage, or disposal facility. Alternatively, waste generators can get a permit to manage the waste on their own property, but permits will only be granted to those meeting criteria for environmentally safe management.

Safe management, as defined in the EPA's proposed regulations implementing Subtitle C, means that all hazardous waste landfills must be lined with clay, plastic, or other impermeable material to prevent waste from moving through the soil and reaching water.[28] Landfills must be at least 500 feet from a water source, and once a site is closed, it must be entirely sealed with clay or other impermeable material. Active sites would be monitored constantly. Closed sites would be monitored and maintained for 20 years by the owners to assure that waste is not moving. A financial responsibility requirement would insure that the owner would be able to assume financial responsibility for up to $5 million per damage incident during the site's operation.

The Act has not yet been implemented due in large measure to limited data and availability of resources, and to the complexity of the scientific and technical issues. All the deadlines established in the law for 1977 and 1978 were missed. Actual implementation of RCRA will probably begin in 1980 and it will be 5 years or more before all sites are fully permitted.

The first step in implementing RCRA is the promulgation of rules by EPA.[29] EPA spent most of 1978 drawing up proposed regulations for carrying out the law, and in early 1979 environmentalists, state officials, chemical industry executives, and others commented on the proposals.

The proposed regulations indicate graphically the level of complexity involved in controlling the spread of hazardous wastes. Some 275,000 generators of hazardous materials are to be involved, with 30,000 permits issued for treatment, storage, and disposal. There are detailed descriptions of physical, chemical, and biological tests to be

performed on wastes to determine their toxicity, flammability, reactivity, corrosiveness, infectiousness, radioactivity, phytotoxcity, teratogenicity, and mutagenicity; there are lists of manufacturing processes that are subject to control; there are other lists of poisons, pollutants, pesticides, and bacterial agents; there are definitions of management techniques, floodplains, the height of fences, the size of warning signs, and the permissible exposure levels for airborne contaminants; and much more.

Criticism of the proposed rules came from several quarters, reflecting opposite points of view. Some environmentalists charged that important toxic chemicals—including Tris and asbestos, both carcinogens—were not included in the proposed regulations. They also disputed the agency's proposal that "small generators" of hazardous wastes (those producing 100 kilograms per month or less) should be exempted from most of the Act's burdens, citing many accidents and examples of pollution resulting from mishandling of small quantities of chemicals.[30] They also urged that operators of waste disposal sites should not be allowed to wait for a final permit before being required to monitor for possible ground water contamination from their operations.[31]

The chemical industry generally criticized the procedures for testing chemicals, claiming they were too costly and they should be less general and more reflective of the specific hazardous characteristics of the substances. The industry suggested that testing would be so expensive and difficult that many small companies would rather declare all their wastes hazardous than determine which really were not—thus vastly increasing the amount of hazardous wastes. Some states supported the industry's concerns. Some also criticized EPA for issuing what amounted to design standards for hazardous waste facilities rather than performance standards; under the latter, innovative technologies such as incineration, resource recovery, and waste stabilization would be encouraged.[32]

EPA will make any necessary changes in the regulation and anticipates publication of final regulations in December 1979. The regulations will be effective 6 months after promulgation.

THE OIL, HAZARDOUS SUBSTANCES, AND HAZARDOUS WASTE RESPONSE, LIABILITY AND COMPENSATION ACT

RCRA's regulatory program does not address the abandoned and inactive dumps. When RCRA was passed in 1976, public awareness about the "ticking time bombs" all around us was low, so the Act addressed only currently-used disposal sites and those to be designed and used in the future.

In June 1979, the Carter Administration proposed legislation to set up a $1.6 billion fund to cover the costs of cleaning up emergencies like Love Canal, and to respond to emergency hazardous substances and oil spills.[33] The fund would be financed through fees levied on the oil and chemical industries together with a federal appropriation.

Under the comprehensive bill, the government would be notified of any inactive or abandoned hazardous waste disposal site (as well as any spill that was currently releasing oil, hazardous substances, or hazardous wastes to the environment). The government would then be empowered to clean up and mitigate the pollution from the disposal site (or from a spill) that presented a danger to health or the environment. Government operations could begin immediately if the responsible parties did not respond properly or could not be found. The government could then turn around and sue the responsible individuals or company for the costs of cleanup. For dump sites the government could recover up to two and a half times its cost. In the event of emergency spills (but not in the event of leaching from abandoned dumps), the fund could also provide financial compensation to innocent victims for property damage and certain other economic loss caused by the spill.

The legislation, built upon and incorporating provisions from the Clean Water Act, the proposed Comprehensive Oil Pollution Liability and Compensation Act, and the Solid Waste Disposal Act, would greatly increase the government's ability to react to hazardous chemical emergencies. Currently, when a responsible disposal site owner or spiller cannot be found or is financially unable, government cleanup is specifically authorized only in limited cases: that is, when the disposal site discharges oil or specifically designated hazardous substances into navigable waters. For other spills, even when the responsible party is found, if the party is unwilling to pay for cleanup the government generally does not initiate it and sue later; it can usually only seek a court order requiring the responsible party to clean up the spill. This means going through a lengthy judicial process.

The $1.6 billion fund would be phased in, eventually reaching a rate of $500 million annually and would be derived primarily from fees on oil, organic chemical feed stocks, and certain other inorganic elements and compounds; a federal appropriation; recovered costs; penalties; and interest on a $50 million capital reserve. The bill provides for a reassessment of the problem in 3 years, after additional experience has been gained and more information has been gathered.

Meanwhile, the Department of Justice and EPA announced in May 1979 that they were sharply stepping up investigation and enforcement efforts on hazardous waste disposal sites. EPA diverted approximately 100 employees from other duties to carry out investigations of dump sites and to help prepare cases for prosecution by the Justice Department. To support this effort the Administration also sought supplemental budget appropriations for fiscal year 1980 for both EPA and the Department of Justice.

SITING NEW FACILITIES

The siting of new disposal facilities is one of the most difficult problems related to hazardous waste disposal.

Adequate treatment and disposal capacity is critical to a successful regulatory program. Authorities also agree that the nation will need considerably more sites as a larger number of wastes will be classified hazardous in the future, and as wastes that are currently being stored or disposed of in an environmentally unsound manner will have to be transferred to adequate facilities. Moreover, once RCRA's standards are implemented, many companies now disposing of wastes on their own property will find it uneconomical to upgrade their own facilities to meet the EPA standards and thus will be seeking offsite disposal alternatives. Although over the long run RCRA may encourage processors to recycle hazardous materials or shift to safer substances, this reduction in the generation of toxic materials is not likely to occur immediately. EPA predicted in 1978 that at least 50 to 60 new disposal sites would be needed nationally, with possibly as many as 10 in New Jersey.[34]

Local public opposition to new disposal facilities has proved to be almost unanimous. This is not surprising, considering the wide publicity given hazardous waste disposal problems. People stated they were fearful of ground water contamination, air and land pollution, fires, explosion, and spills. They also protested reduced property values as well as being the dumping ground for someone else's wastes.[35]

Some states have tried to site a hazardous waste facility and failed because of citizen opposition. A striking example occurred in Minnesota. In 1975, the state's Pollution Control Agency received a $3.7 million grant from EPA to establish a chemical landfill and demonstrate that it could be operated in an environmentally safe manner. After 44 potential sites were identified and the list narrowed to the 16 best ones, each was rejected by citizen opponents. Finally, in August 1978, the agency abandoned the search and returned the grant funds to EPA.[36]

There are no easy answers to the siting problem, and indeed it may get worse. Some observers believe that the only way land for a facility can be obtained is through eminent domain, with state or federal override of local zoning board opposition. Some proposals take into account the realities of the siting question: placing a facility in an already heavily industrialized area might be less likely to arouse the wrath of homeowners; or siting one in a remote, isolated area would stir up less opposition because such a location by definition has fewer neighbors. Of course, a demonstration that hazardous waste facilities can be operated without negative health or environmental impact and public education on the results would help significantly to gain public support.

OUTLOOK FOR THE FUTURE

At present, the government's philosophy on hazardous wastes is to find out as much information as possible about all aspects of waste generation, and to dispose of (or store) the wastes securely. This is a

prudent policy, considering how little is currently known and how much hazardous material appears to be finding its way into the environment. However, over the long term, such concepts as "disposal," "storage," and "containment" should give way in large part to techniques such as waste neutralization, recycling, and the substitution of safer materials. Already there are some hopeful signs. The paper industry, which historically produced large quantities of waste effluents, has instituted numerous recycling techniques in its manufacturing processes to reduce waste and conserve materials. Due in large measure to a changing economic picture since the 1973 oil embargo and price rise, the solvents industry seems to be following suit by recycling spent solvents.

Finding safer substitutes could offer a still more satisfactory solution. Already an enterprising inventor in Florida has discovered how to make an industrial hand-cleaner out of citrus wastes rather than from petroleum derivatives, thus helping solve two environmental problems at the same time. With breakthroughs in sophisticated organic agriculture and integrated pest management, the production of extremely toxic pesticides—and their hazardous waste products—may also decrease.

As with many other environmental problems, the force of the marketplace is expected to effect the greatest changes, once the cost of disposal is internalized into the final cost of the product. As the cost of hazardous waste handling and disposal (as well as the price of many raw materials) rises, industrial recycling and reprocessing and the substitution of less dangerous materials will be given a significant new impetus.

ENVIRONMENTAL FACTORS AND CANCER

Of all the major causes of death in the United States, only one has continued to rise, year after year, throughout this century: cancer. While deaths from infectious diseases have dropped dramatically and even deaths from accidents have fluctuated through the years, the cancer toll has mounted steadily. The increase reflects in part the larger number of older people in our society. However, even after adjustments for age, the rate of cancer mortality—deaths due to cancer—has been increasing by 0.5 percent annually in the United States and the rate of incidence—new cases—by 1.6 percent.[37]

Why the continued increase? Specific causes cannot be singled out with certainty. In former years, medical and scientific opinion emphasized inborn genetic susceptibility as a cause of cancer—a natural occurrence. This is understandable as it now appears that a genetic mutation is a first step in the development of cancer. However, there is compelling evidence pointing to something more than just inborn genetic factors. Studies of cancer risks in various countries around the world have revealed that the most prevalent kinds of cancer—lung cancer, stomach cancer, breast cancer, cancer of the colon and

rectum—differ in frequency greatly from one country to another. Yet, immigrants show the characteristic cancer risk pattern of the adopted country within a generation or two, even when the new country's prevalent pattern is substantially different from that of the old.

Thus, scientists today have concluded that cancer is not altogether or even primarily a result of our racial or genetic heritage, but reflects factors in our physical and chemical environment. In fact, it is generally agreed that environmental, that is, exogenous nongenetic, factors contribute to as much as 80 to 90 percent of cancers.[38]

Since the passage of the National Cancer Act in 1971, the nation's cancer policy has emphasized three points: a basic understanding of the biological and biochemical bases of cancer; better methods of intervention, diagnosis, and treatment; and identification of environmental and genetic causes of cancer. Major benefits in reducing cancer are likely to accrue from identifying and evaluating environmental factors and then reducing exposure to them.

What is meant by "environmental" factors? Broadly, this term refers to all factors that are not genetic and not related to the body's natural aging process. They include smoking, diet, occupation, radiation, pollution, viruses, and stress. However, because not all people exposed to these factors develop cancer, susceptibility appears also to depend on a number of modifying factors, such as immune status, nutritional excesses or deficiencies, and genetics.

In the early 1970s when the National Cancer Act was passed, many scientists and physicians believed that viruses were a major cause of cancer. Therefore, much effort was spent identifying and studying viruses in the hope of developing vaccines against them. However, viruses have been implicated in only a few kinds of human cancer, and the evidence is still not clear. On the other hand, chemicals such as bis (chloromethyl) ether and physical agents, such as x-rays, have been found to be a factor in a much larger number of cancer types.

Some environmental factors are natural, such as the sun's rays, other background radiation, the presence of aflatoxins in foods as a result of secretion by certain molds, and the production of benzo(a) pyrene from forest fires. Table 3–1 lists some natural environmental factors. Even certain sexual practices may carry a cancer risk. Epidemiological studies have pointed to several risk factors for cervical cancer; among them are early age of coitus, multiple sexual partners, and multiple marriages and pregnancies. A virus may be involved, possibly herpes simplex virus, type 2. Celibate women are at very low risk for cervical cancer.[39]

Other factors causing cancer are the result of human invention. For the U.S. population as a whole, medical x-rays add 75 percent to exposures to ionizing radiation from natural sources (see Table 3–2). Certain drugs have been shown to be carcinogens (see Table 3–3). Chemicals such as vinyl chloride to which people have been exposed intensively on the job cause cancer, as do physical agents such as asbestos (see Table 3–4).

Table 3–1

Some Natural Environmental Factors and Cancer

Agent	Site or Type of Cancer
Sunlight	Exposed skin (squamous carcinoma, melanoma [?])
Use of "kangri" and "dhoti"	Skin of abdomen and thigh
Chewing betel, tobacco, lime	Mouth
Reverse smoking	Palate
Smoking	Mouth, pharynx, larynx, brochus esophagus, bladder
Alcoholic drinks	Mouth, pharynx, larynx, esophagus
Aspect of sexual intercourse (? virus)	Cervix uteri
Infectious mononucleosis (?)	Hodgkin's disease
Aflatoxin	Liver
Shistosomiasis	Bladder

?=Suggestive, but not conclusive, association.

Source: Adapted from R. Doll, "Introduction," in H. H. Hiatt, J. D. Watson, and J. A. Winsten, eds. *Origins of Human Cancer*, Cold Spring Harbor Conferences on Cell Proliferation, Vol. 4 (Cold Spring Harbor, N.Y.: Cold Spring Harbor Laboratory, 1977), p. 4.

Table 3–2

Manmade Sources of Average Exposures to Ionizing Radiation to U.S. Population as Percentage of Naturally Occurring Background Exposures [a]

Source	Percentage
Naturally occurring background	100
Medical X-rays [b]	74
Radiopharmaceuticals [c]	16
Weapons fallout	2
Other sources (nuclear fuel cycle, jet travel, consumer products, etc.)	1

[a] Average exposures to an individual living in the United States; some individuals could receive much higher or lower exposures of occupational sources or local natural conditions.

[b] Dose to adult bone marrow.

[c] A rough estimate of expected whole body dose by the year 1980.

Source: U.S. Environmental Protection Agency, *Radiological Quality of the Environment in the United States* (Washington, D.C.: U.S. Government Printing Office, 1977), reprinted from CEQ, *Environmental Quality—1978* (Washington, D.C.: U.S. Government Printing Office, 1978), p. 384.

The use of tobacco, which was first hypothesized to cause cancer in 1761 by the English physician John Hall, has been repeatedly and unmistakably shown to be carcinogenic, although the exact chemicals in tar that induce or promote cancer are not known. Cigarette smoking is a major factor contributing to cancer in the United States. However, smoking interacts with certain occupational carcinogens, air pollutants, and probably other factors not yet identified that increase cancer risks among smokers. Examples of this are the much

Table 3–3

Drug Exposures or Treatments and Cancer

Agent	Site of Cancer
Diagnostic or therapeutic X-rays	All sites
Radioisotopes	
Phosphorus (P^{32})	Blood (acute leukemia)
Radium, thorium	Bone (osteosarcoma), sinus (carcinoma)
Thorotrast	R. E. System—liver,spleen (hemangioendothelioma of liver)
Immunosuppressive drugs (for renal transplantation)	
Antilymphocyte serum	Reticulum cell (sarcoma)
Antimetabolites	Soft tissue (sarcoma), skin and liver
Polycyclic hydrocarbons	
Coal-tar ointments	Skin
Liquid paraffin	Stomach, colon, rectum
Cytotoxic drugs	
Chlornaphazine	Bladder
Melphalan cyclophosphamide	Blood (acute myelomonocytic leukemia)
Hormones	
Synthetic estrogens	
Prenatal	Vagina and cervix (adenocarcinoma—clearcell type)
Postnatal	Uterus (endometrial carcinoma—adenosquamous type), breast—female
Androgenic-anabolicsteroids (for aplastic anemia)	Liver (heptatocellular carcinoma)
Others	
Phenacetin	Kidney (renal pelvis carcinoma)
Arsenic	Skin, lungs
Chloramphenicol	Leukemia
Diphenylhydantoin	Lymphoreticular tissue
Oxymetholone	Liver
Amphetamines	Hodgkin's disease
Reserpine	Breast
SV40 virus contaminating polio vaccine (transplacental)(?)	Central nervous system

?=Suggestive, but not conclusive, association.

Source: Adapted from R. Hoover and J. F. Fraumeni, Jr., "Drugs," in J. F. Fraumeni, ed., *Persons at High Risk of Cancer* (New York: Academic Press, 1975), Table 1, p. 187; R. Doll, "Introduction," in H. H. Hiatt, J. D. Watson, and J. A. Winsten, eds., *Origins of Human Cancer*, Cold Spring Harbor Conferences on Cell Proliferation, Vol. 4 (Cold Spring Harbor, N.Y.: Cold Spring Harbor Laboratory, 1977), Table 3, p. 4; and L. Tomatis, C. Agthe, H. Bartsch, J. Huff, R. Montesano, R. Saracci, E. Walker, and J. Wilbourn, "Evaluation of the Carcinogenicity of Chemicals: A Review of the Monograph Program of the International Agency for Research on Cancer (1971 to 1977)," *Cancer Research* 38 (1978), Table 2, pp. 879–880.

higher mortality from oral cancer when smoking is combined with consumption of alcohol, and from lung cancer when smoking combines with exposure to asbestos or exposure to radiation in uranium mining.[40] Thus, not all smoking-related cancers—of the lung, the pancreas, and the bladder—are attributable solely to smoking.[41]

Many people believe that most environmental factors contributing to cancer risks can be controlled once they are identified. But what proportion of cancers can be prevented is not known. Some known factors are difficult to control, for example, exposure to sunlight and other background radiation. Some are the result of personal

Table 3–4

Occupational Cancers

Agent	Occupation	Site of Cancer
Organic Agents		
Aromatic hydrocarbons		
Coal soot, coal tar, other products of coal combustion	Manufacturers of coal gas; asphalt, coal tar, and pitch workers; coke-oven workers; miners (uranium, fluorspar, hematite); still cleaners; chimney sweeps	Lung, larynx, skin, scrotum, bladder
Petroleum, petroleum coke, wax, creosote, anthracene, paraffin, shale, mineral oils	Lubricating, cooling, or fuel oil workers; coke, paraffin, wax, rubber and retort workers; textile weavers; diesel jet testers	Nasal cavity, lung, larynx, skin, scrotum
Benzene	Workers with chemicals, glues, varnishes, explosives, rubber cement; distillers, dye workers, painters, and shoe workers	Bone marrow, leukemia
Auramine, benzidine, 1-naphthylamine, 2-naphthylamine, magenta, 4-aminobiphenyl, 4-nitrobiphenyl	Manufacture and use of dyestuffs; rubber workers, textile dyers, paint manufacturers	Bladder
Others		
Mustard gas	Poison gas makers	Larynx, lung, trachea, bronchi
Isopropyl oil	Isopropylene manufacturers	Nasal sinuses
Vinyl chloride	PVC manufacturers, plastics workers	Liver (angiosarcoma), brain
Bis (chloromethyl) ether, chloromethyl methyl ether	Makers of ion-exchange resins, chemical workers	Lung
Inorganic Agents		
Metals		
Arsenic compounds	Gold miners, smelter workers; some vineyard workers; sheep dip manufacturers, tanners; insecticide makers and sprayers, chemical workers	Skin, lung, liver

Cadmium	Cadmium-using industries	Prostate, bronchus
Chromium	Chromate producers, processors, and users; acetylene and aniline workers; bleachers; glass, pottery, and linoleum workers; battery makers	Nasal cavity and sinuses, lung, larnyx
Iron oxide	Hematite miners, metal grinders and polishers, silver finishers, iron foundry workers	Lung, larynx
Nickel	Nickel refiners, electrolysis workers	Nasal sinuses, lung
Physical Agents		
Ionizing radiation		
X-rays	Radiologists, medical personnel	Skin, bone marrow (leukemia)
Uranium, radon, radium mesothorium	Radiologists, radiographers, miners of uranium, fluorspar, and hematite; radium dial painters; radium chemists	Skin, bone, lung, bone marrow (leukemia)
Non-ionizing radiation		
Ultraviolet rays	Farmers, sailors	Skin
Fibers		
Asbestos	Miners, millers, textile insulation, and shipyard workers	Lung, pleural and peritoneal mesothelioma
Dusts		
Wood	Wood workers	Nasal cavity and sinuses
Leather	Leather and shoe workers	Nasal cavity and sinuses, bladder
Others		
Hypoxia	Caisson workers	Bone

Source: Adapted from R. Doll, "Introduction," in H. H. Hiatt, *et al.*, eds. *Origins of Human Cancer*, Cold Spring Harbor Conferences on Cell Proliferation, Vol. 4 (Cold Spring Harbor, NY: Cold Spring Harbor Laboratory, 1977), p. 3, Table 4; L. Tomatis, *et al.*, "Evaluation of the Carcinogenicity of Chemicals: A Review of the Monograph Program of the International Agency for Research on Cancer (1971 to 1977)," *Cancer Research*, *38*: 877–885 (1978), pp. 879, 880, Table 2; P. Cole and M. B. Goldman, "Occupation," in J. F. Fraumeni, Jr., ed. *Persons at High Risk of Cancer* (New York, Academic Press, 1975), pp. 172–176, Table 1.

habits or lifestyle, such as cigarette smoking and consumption of alcoholic beverages. Others can be more easily controlled, for example, asbestos, ionizing radiation in the environment as a result of human action, some industrial chemicals and drugs, several air and water pollutants, and some food additives and consumer products.

IDENTIFICATION OF CANCER-CAUSING AGENTS

Why has it been so difficult to recognize the role of environmental factors in causing cancer and to identify specific carcinogens in the environment? The primary reason is the long latency period of the disease. Generally, cancers associated with identified environmental agents do not become clinically evident for about 15 to 40 years after exposure; the period can be as low as 2 years and can sometimes extend to half a century.[42] This latent period greatly complicates the study in humans of possible causes of cancer. Keeping track of large groups of identified individuals over so many years is an enormous practical difficulty. A few such studies have been done, such as the 16-year mortality study of cigarette smokers among veterans.[43] But most of the human evidence that exists about carcinogens in the environment comes from heavy occupational exposures to chemical or physical agents, or intensive medical exposures to radiation or drugs.

Proven examples of cancer from job exposures are as old as the discovery by Sir Percival Potts in 1775 of scrotal cancer in chimney sweeps from exposure to soot.[44] Well-known modern examples are the increased incidence of cancer among coke-oven workers exposed to various soots and tars; distillers, dye-users, and workers in explosives or rubber cement exposed to benzene; plastic workers exposed to vinyl chloride; miners of uranium, fluorspar, and hematite (iron ore) exposed to radon gas; and smelter workers exposed to arsenic or nickel. Table 3–4 contains a list of agents, occupations, and the cancers to which they have been linked.

Even in the workplace, where exposures are often greatest and the effects most easily observed, many types of human exposures have never been measured accurately and recorded. Many companies do not keep detailed records of their production methods and facilities. Furthermore, the average worker changes exposure patterns in moving from job to job, and workers are often exposed to a complex mix of agents inside many industrial facilities.

Exposure on the job to asbestos illustrates the magnitude of the problem of identifying cancer-causing agents through human experience. It has been estimated that between 8 and 11 million workers have been exposed to asbestos in the United States since the beginning of World War II.[45] About 4 million have had high exposure. Among those heavily exposed workers who have already died from any cause, 20 to 25 percent succumbed to lung cancer, 7 to 10 percent died of mesothelioma (cancer of the lining of the chest or stomach), and 8 to 9 percent died of gastrointestinal cancer. In all, 35 to 44 percent

of the heavily exposed deceased workers are known to have died of cancer of these organs. Because most exposed workers are still alive, the lifetime cancer risks may prove to be still higher. In the absence of exposure to asbestos, only 8 to 9 percent would have been expected to die from these types of cancers. This compelling record took many years of meticulous research to document and did not even begin to reach public consciousness until the 1970s—30 years after much of the intensive asbestos exposure began.

"Perhaps the most important lesson to be learned from the asbestos story," concludes a recent report on cancer in the workplace by scientists at the National Institute for Occupational Safety and Health, the National Institute of Environmental Health Sciences, and the National Cancer Institute, "is that a major public health disaster can develop while its early manifestations are lost by being attributed to other factors." [46]

Recent figures show that certain specific occupational groups appear to contact cancer at rates significantly above those of the population at large (see Table 3–5). For instance, coal miners get stomach cancer at a 40 percent higher rate than the general public; printing pressmen get mouth cancer 125 percent more often than others; and workers in shoe factories have 700 percent more cancer of the nasal

Table 3–5

Occupational Groups in Which Excess Cancer Incidence Has Been Reported Without Identification of a Specific Cancer-Causing Agent

Occupational Groups	Cancer Site(s)	Percent Excess Reported
Coal miners	Stomach	40
Chemists	Pancreas,	54
	lymphomas	79
Foundry workers	Lung	50–150
Textile workers	Mouth and pharynx	77
Printing pressmen (newspaper)	Mouth and pharynx	125
Metal miners	Lung	200
Coke by-product workers	Large intestine,	181
	pancreas	312
Cadmium production workers	Lung,	135
	prostate	248
Rubber industry		
Processing	Stomach,	80
	leukemia	140
Tire building	Bladder,	88
	brain	90
Tire curing	Lung	61
Furniture workers	Nasal cavity and sinuses	300–400
Shoe workers	Nasal cavity and sinuses,	700
	leukemia	100
Leather workers	Bladder	150

Source: Adapted from K. Bridbord, P. Decoufle, J. Fraumeni, Jr., D. Hoel, R. Hoover, D. Rall, U. Saffiotti, M. Schneiderman, and A. Upton, *Estimates of the Fraction of Cancer in the United States Related to Occupational Factors* (Washington, D.C., U.S. Department of Health, Education, and Welfare, September 15, 1978), p. 39-Table 3.

cavity and sinuses and 100 times more leukemia than the average person. Except for leukemia in shoe workers, for which benzene is the suspected agent, the actual cancer-causing substance has not yet been identified in these cases.[47]

Additional evidence of environmental factors contributing to cancer is the geographic patterns of cancer mortality and incidence rates in the United States, generally showing higher rates in industrialized, densely populated areas than in rural areas. This correlation is particularly true for lung cancer in men. Cigarette smoking, which is higher in urban areas than in rural areas, is one factor. Exposure to carcinogens on the job is probably also involved, but probably accounts for the excess only in certain geographical areas. The excess also correlates with air pollution acting in conjunction with cigarette smoking; the correlation is even stronger in areas where measured levels of benzo(a)pyrene in air are used as a measure of air pollution.[48]

OPPORTUNITIES FOR PREVENTION

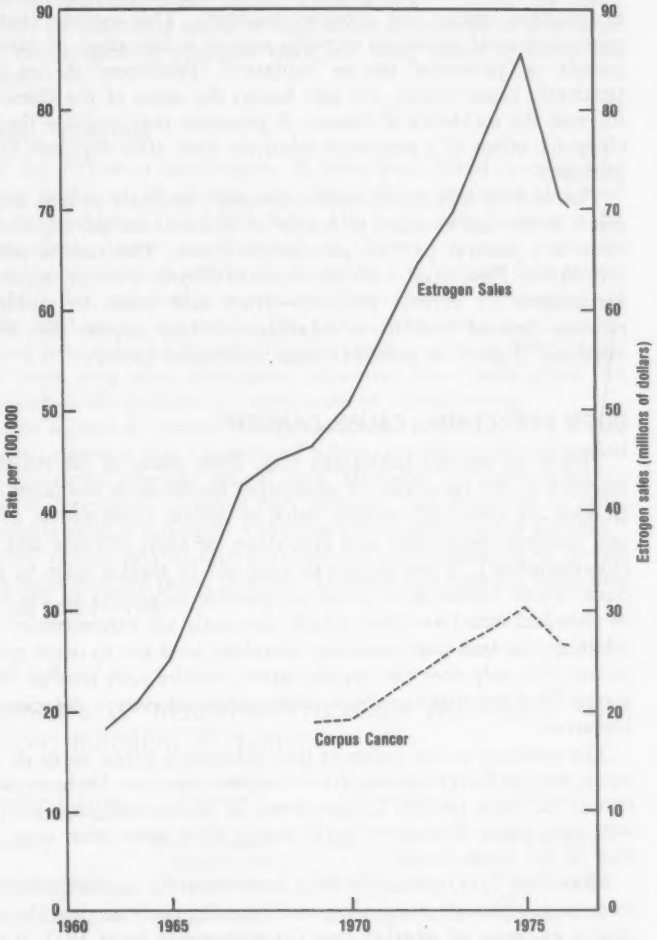
It is very difficult to attribute with any degree of accuracy the observed incidence of cancer to specific factors—pollutants, manufactured chemicals, dietary components, or contaminants. However, a recent government estimate places the fraction of cancer that is related to occupational factors at 20 to 38 percent, for the present and the next several decades.[49] This estimate is based on figures for workers highly exposed to certain carcinogens—asbestos, arsenic, benzene, chromates, nickel oxides, and petroleum derivatives. The epidemiological studies upon which this estimate is based do not contain accurate data on exposure levels, and hence the degree of risk is uncertain. The American Industrial Health Council challenged the estimate on this and other grounds, but it was re-estimated for them by Dr. R. Stallones at the University of Texas, who arrived at a similar range of 10 to 33 percent.[50]

Previous estimates of the amount of cancer due to occupational exposure had been much lower (1 to 5 percent [51] and 10 to 15 percent [52]). The earlier studies were made on a one-cause, one-effect basis and also lacked some recent significant data. Our current knowledge of cancer and the interactions among causative factors suggests that many cancers probably result from the combined effects of long-term exposures to several "weak" carcinogens acting together (in an additive or synergistic way) rather than from sporadic exposure to a few "potent" carcinogens. If so, most cancers may be the result of several causative agents, some of which are potentially preventable. Cancers appear to be multistaged, and different environmental factors may trigger different stages in the progression to malignancy. This may be one reason why some people exposed to a cancer-causing agent develop cancer although others do not.

Evidence of this multistage effect may be drawn from recent figures showing a drop in endometrial cancer (cancer of the lining of the uterus) in white females. As Figure 3–1 shows, this type of cancer

Figure 3–1

Age-Adjusted (1950 U.S. Standard) Incidence Rates for Corpus Cancer in White Females and Estrogen Sales in the United States



Source: (Estrogen sales) U.S. Department of Commerce, Bureau of Census, Industrial Division "Current Industrial Reports." Pharmaceutical Preparations—except Biological—1962–1976, Series No.–28G(62)–IMA–28G(76)–1; (Corpus cancer) "Third National Cancer Survey, 1969–1971," Monograph 41, S. Cutler and J. Young, Eds., "Third National Cancer Survey Incidence Data"; 1973–1977, data from SEER program, unpublished.

appeared to drop within 1 year of widespread publicity linking the cancer to the use of postmenopausal estrogen.[53] Previously this cancer had been reported to be rising rapidly. Part of the publicity was a Food and Drug Administration (FDA) requirement for warning inserts in packages of the drug. First sales dropped, then astonishingly quickly—considering the usual latency period for cancer—endometrial cancer also dropped markedly. This suggests that for postmenopausal exposure, estrogen acts at a late stage of carcinogenesis—a "promoter" not an "initiator." "Promoters" do not independently cause cancer, but can hasten the onset of the disease or increase the incidence of tumors. A promoter may increase the carcinogenic effect of a substance relatively soon after exposure to the initiator.

The task of identifying cancer-causing chemicals so that appropriate action can be taken to reduce or eliminate human exposure to them is a central part of prevention efforts. The task is plainly formidable. First of all, with the constant discovery of new suspected carcinogens in various products—from diet sodas to children's pajamas treated with flame retardant—it may appear that about anything, if given in sufficient doses, will cause cancer.

DOES EVERYTHING CAUSE CANCER?

This is an entirely misleading idea. First, many of the materials revealed in the succession of newspaper headlines as the latest carcinogen are chemically related (such as various nitrosomines, aldrin and dieldrin, heptachlor and chlordane, or vinyl chloride and trichloroethylene). These chemicals may act in similar ways to produce cancer (although it is not yet possible to predict on the basis of chemical structure alone which chemicals are carcinogenic). In addition, the tests that exonerate chemicals tend not to reach public notice. Not only does the popular press consider such tests as "nonevents," but the tests have been rarely published even in the scientific literature.

The evidence so far indicates that substances either do or do not cause cancer. Larger doses of carcinogens are more likely to cause cancer in more people. Larger doses of noncarcinogens—such as salt—may cause damage or make people ill in some other way, but they do not cause cancer.

More than 7,000 substances have been tested for carcinogenicity in some way, although many were tested inadequately to provide conclusive evidence of whether they cause cancer.[54] As of 1977, it was estimated that only about 1,500 of the tested chemicals had been investigated sufficiently to draw some conclusions about their carcinogenicity, and about 600 to 800 had shown substantial, positive evidence of carcinogenicity.[55] Through the bioassay program at the National Cancer Institute, about 250 chemicals have been tested and evaluated to date. Approximately half have been reported as positive. Most of the chemicals were selected for testing because there

was some evidence to suspect that they were carcinogens, for example, if they were structurally similar in some way to known carcinogens. In one study of approximately 120 industrial and pesticide chemicals tested at high doses in mice, less than 20 percent showed any indication of carcinogenicity, and only half of them (or about 10 percent) were clearly carcinogenic.[56] Thus, the large majority of chemicals tested at high doses in animals to determine their cancer-causing potential have not been found to cause the disease.

ANIMAL TESTING

Of the 700 or so carcinogens, 26 have been linked to cancer by human evidence; 18 of these are chemicals or processes identified with the workplace (see Table 3–6). The list is likely to grow as the International Agency for Research on Cancer continues to review the carcinogenicity of additional chemicals and publish their monographs.[57] But, as noted, the evidence from human epidemiological studies trickles in very slowly. The fact is that detection of cancer-causing substances by human evidence alone is not only difficult, but may come long after widespread exposures have taken place. An approach to the problem is intensive use of animal testing.

Some aspects of animal testing have been criticized. And it may turn out someday that a number of substances were falsely identified as carcinogens through animal tests. However, scientists generally agree that properly qualified tests on mice, rats, hamsters, or other mammals yield meaningful results on carcinogenicity for humans.[58] Indeed, crucial animal tests revealed the carcinogenicity of several substances that did prove to cause cancer among humans when they became widely used.[59]

Table 3–6

Chemicals or Industrial Processes Associated With Cancer Induction in Humans

Chemical or Industrial Process	Main Type of Exposure [a]	Target Organs in Humans	Main Source of Exposure [b]
Aflatoxins	Environmental, occupational [c]	Liver	Oral, inhalation [c]
4-Aminobiphenyl	Occupational	Bladder	Inhalation, skin, oral
Arsenic compounds	Occupational, medicinal, environmental	Skin, lung, liver [c]	Inhalation, skin, oral
Asbestos	Occupational	Lung, pleural cavity, G.I. tract	Inhalation, oral
Auramine manufacturing	Occupational	Bladder	Inhalation, skin, oral
Benzene	Occupational	Hemopoietic system	Inhalation, skin
Benzidine	Occupational	Bladder	Inhalation, skin, oral

Table 3–6 (continued)

Chemical or Industrial Process	Main Type of Exposure [a]	Target Organs in Humans	Main Source of Exposure [b]
Bis (chloromethyl)-ether	Occupational	Lung	Inhalation
Cadmium-using industries (possibly cadmium oxides)	Occupational	Prostate, lung	Inhalation, oral
Chloramphenicol	Medicinal	Hemopoietic system	Oral, injection
Chloromethyl ether (possibly associated with bis(chloromethyl) ether	Occupational	Lung	Inhalation
Chromate-producing industries	Occupational	Lung, nasal cavities [c]	Inhalation
Cyclophosphamide	Medicinal	Bladder	Oral, injection
Diethylstilbestrol (DES)	Medicinal	Uterus, vagina	Oral
Hematite mining	Occupational	Lung	Inhalation
Isopropyl oil	Occupational	Nasal cavity, larynx	Inhalation
Melphalan	Medicinal	Hemopoietic system	Oral, injection
Mustard gas	Occupational	Lung, larynx	Inhalation
2-Naphthylamine	Occupational	Bladder	Inhalation, skin, oral
Nickel refining	Occupational	Nasal cavity, lung	Inhalation
N,N-bis (2-chloroethyl)-2-naphthylamine (chlornaphazine)	Medicinal	Bladder	Oral
Oxymetholone	Medicinal	Liver	Oral
Phenacetin	Medicinal	Kidney	Oral
Phenytoin	Medicinal	Lymphoreticular tissues	Oral, injection
Soot, tars, and oils	Occupational, environmental	Lung, skin, scrotum	Inhalation, skin
Vinyl chloride	Occupational	Liver, brain,[c] lung [c]	Inhalation, skin

[a] The main types of exposure mentioned are those by which the association has been demonstrated.

[b] The main routes of exposure given may not be the only ones by which such effects could occur.

[c] Denotes indicative evidence.

Source: Adapted from L. Tomatis, *et al.*, "Evaluation of the Carcinogenicity of Chemicals: A Review of the Monograph Program of the International Agency for Research on Cancer, (1971–1977)," *Cancer Research* 38: 877–885 (1978), pp. 879–889, Table 2.

In the early 1940s, diethylstilbestrol (DES) was shown to produce tumors in animals, and the results of these tests were confirmed a decade later in several animal species. Nevertheless, the drug was heavily used between 1945 and 1955, and continued to be used through the 1960s, as a means to prevent miscarriages. Vaginal cancer is showing up now in many of the daughters of women who were treated with DES.[60] Sons are also at increased risk of genital abnormalities.

In 1970, a paper describing the carcinogenicity of vinyl chloride based on rat studies was delivered at an international cancer congress. No action was taken at that time to protect vinyl chloride workers from high exposure levels. And 4 years later, evidence in workers themselves linked vinyl chloride to a rare form of liver cancer (angiosarcoma).[61] As the evidence mounted, plastics workers were found to be at approximately 200 times higher than average risk of liver cancer, and about 4 times the average risk of brain cancer.[62]

An unusual clustering of lung cancer cases was noted as early as 1962 among workers in a company that manufactured bis(chloromethyl)ether (BCME), but it took more than a decade before this causal relationship was clear and workers protected. Results of tests showing the carcinogenicity of BCME in rodents appeared in 1968, and were confirmed by additional tests the following year. In these tests, the chemical was applied to the skin of mice and rats or injected subcutaneously. The evidence from animal tests was not considered convincing until 1971, when rats exposed to BCME by inhalation—the same route of administration as in human exposure—were reported to have significantly increased incidences of lung and nasal cavity tumors. Within 2 years, epidemiological studies further confirmed a causal relationship between exposure to BCME and the occurrence of lung cancer in humans. Only then were measures to reduce exposure to the carcinogen seriously discussed.[63]

The increased incidence of cancer in laboratory animals has gained scientific acceptance as a warning requiring action to protect humans. In the early 1940s, 2-acetylaminofluorene (2-AAF), which was ready for large-scale production as an insecticide, was withdrawn because one experiment indicated that it caused cancer in rats.[64] In more recent years, alkyl nitrosamines, chloroform, aldrin/dieldrin, heptachlor/chlordane, Kepone, tris (2,3-dibromopropyl) phosphate ("Tris"), ethyleneimine, saccharin, and other chemicals used in a variety of industries and in foods and insecticides have been regulated as carcinogens without proof that they have caused cancer in humans. The actions were all based on the evidence from laboratory animals. (However, not all these carcinogens have actually been removed from the market.)

The principal criticisms of animal testing have concerned dose levels, routes of exposure, benign versus malignant tumors, and threshold levels of exposure.

Dose levels Test methods in which chemicals are administered at doses far higher than those commonly encountered by the population-at-large have been the subject of criticism and widespread misunderstanding by affected industries and the public. A recent controversy concerned saccharin. Critics charged that rats were fed the equivalent of 800 bottles of artificially sweetened soft drinks per day in a test that indicated the carcinogenicity of saccharin. Who, they asked, would ever drink that much soda?

Scientists reply that this is the wrong question. The reason for using high doses is to obtain statistically valid results with a few

hundred animals. First, exposures to the animals over their lifetime of about 2 years is extrapolated to humans who may be exposed for many years, perhaps a lifetime. There is evidence that the risk of cancer increases rapidly with length of exposure.

Second, there is another rather subtler statistical reason for using large doses with experimental animals.[65] Picture two groups of 100 animals apiece, one a control group, and one treated with a suspected carcinogen. If there were no tumors in the control group, the lowest incidence in the group of treated animals that we could consider statistically valid with 95 percent confidence is 3 percent. An incidence of 3 percent would be enormous in the U.S. population—66,000 out of 220 million people. Any substance that induced that much cancer would probably be rejected outright, even if there were substantial benefits to its use. Even 0.3 percent is a very high risk for a large population. Yet, to detect an incidence as low as 0.3 percent, at the 95 percent confidence level, would require test groups of 1,000 animals. To detect incidence levels of 0.03 percent or lower—which are closer to the lifetime risks of the more common human cancers—would require tests of hundreds of thousands of animals. This is not practical. What *is* practical is in essence to make one animal stand in for a thousand—by increasing the dosage. Increasing the dosage means that cancers will occur more frequently, so that they can be detected in a group of 100 animals.

In addition, some of the ways in which small rodents and humans differ support the use of high doses in animal studies.[66] In general, substances ingested by humans are distributed more slowly and tend to persist longer than those ingested by mice or rats. Blood circulates about 20 times faster in mice than in humans. Also, the way in which many substances are broken down and eliminated from the body is slower in humans than in small animals. Even the number of susceptible cells is larger in humans than in small animals—a mouse experiment using 160 to 3,000 animals represents about the same number of susceptible cells (depending on the type of cell) as are contained in one person.

On the other hand, it has been argued that the high doses used in animal tests may overload the body's normal mechanisms for getting rid of foreign materials. Because of the expense, very few studies have been performed with large numbers of animals at low doses. However, the National Center for Toxicological Research (NCTR) recently conducted a study with 24,000 animals of 2-acetylaminofluorene, with doses ranging down to 30 ppm (considerably lower than in previous studies).[67] Cancer was induced at all levels, even the lowest. The implication of this result is that the physiological effects of high and low doses are not essentially different.

In this and another study with vinyl chloride,[68] continuous high doses were compared with a single high dose and to intermittent exposures. Tumors were found to occur as a result of each type of exposure, which further supports the use of continuous high doses

Tests on rats, mice, hamsters, and other mammals identify substances that are likely to cause cancer in human beings.

over the lifetime of the animals as a means of detecting the cancers in small groups of animals.

The high dose levels used in animal experiments are set at the "estimated maximum tolerated dose" (EMTD)—the highest dose compatible with survival without significant toxic effect (such as no greater than a 10 percent decrease in body weight).[69] In the case of saccharin, the EMTD is quite high because the sweetener is not otherwise toxic; in the case of vinyl chloride, the chemical is more poisonous and the EMTD is considerably lower.

Routes of Exposure A prominent element in criticism of animal tests is that the method of administering a suspected substance to animals may differ from the expected route of human exposure. Evaluation of animal tests is simplified when the animals are exposed in the same way that humans are or will be exposed, but there are good scientific reasons for sometimes using different routes in

animals. For example, when it is important to know the exact amount of a test substance administered to animals in a feeding study, a stomach tube may be used. It might be particularly important to use this route if a disagreeable odor or taste of a chemical prevents administration of higher doses.[70] Skin tests were often used as indicators of carcinogenicity because they are convenient. Their results have often been confirmed by feeding studies, or more difficult inhalation tests. In using a route of administration different from that expected in humans, consideration is given to any differences in the absorption and fate of the test substances, as administered to the animals, compared to potential human routes of exposure.

Routes of exposure useful or necessary for different regulatory purposes may differ for a particular substance. For example, when a food additive or drug is considered by the Food and Drug Administration, ingestion is usually the most important route, but when the same substance is handled directly in an occupational setting, skin absorption or inhalation could be more important.

Benign vs. Malignant Tumors In most cases, when chemical or physical agents are found to induce tumors in test animals, both benign and malignant tumors appear. It is sometimes claimed that only malignant tumors should be counted in determining statistical significance of cancer-causing potential.[71] However, even where clear malignancies do not occur but many benign tumors are observed, the conclusion that the chemical is not carcinogenic may not be warranted. Some tumors pass through benign stages before they progress to malignancies, and certain benign tumors are precursors to malignancies. Furthermore, some agents known to cause cancer in humans, such as x-rays and certain polycyclic hydrocarbons, principally induce benign tumors (i.e., mammary fibroadenomas) in one strain of animals and malignant tumors (i.e., mammary adenocarcinomas) in other strains. (However, this result may be due to inadequate tests.) The preponderance of scientific opinion is that findings of all kinds of tumors are an indication of potential carcinogenicity.[72] Furthermore, benign tumors themselves can jeopardize health and life.

Threshold Levels of Exposure Many manufacturers argue that it is uneconomic and unnecessary to purge their products or workplaces of every trace of carcinogenic substances. They contend that every carcinogen has a threshold value below which it is safe. The present scientific consensus is that no method now exists to determine "safe" or threshold levels of exposure to carcinogens.[73]

The major problem in determining whether there are safe exposure levels is the paucity of data on the effects of carcinogens at low exposure levels. Most of what we know about the dose-response of carcinogens comes from highly exposed workers, from patients treated with drugs or radiation at fairly high levels, and from animal studies, for the most part at high doses. These data on high level exposures shed little light on whether there are thresholds of safe exposures at lower levels. However, the NCTR study of low doses with a larger numbers of animals, described above, found no safe or threshold dose.

This unique study was designed specifically to enlarge knowledge of effects at low doses, including the question of whether safe exposure levels exist.

When risks at high levels of exposure are extrapolated to predict risks at the generally low levels to which most humans are exposed, the shape of the dose-response curve in the low dose region—whether straight, concave, or otherwise—is uncertain. In general, as the dose of a carcinogen increases, the frequency of cancer increases, often in a direct or linear relationship. For low levels, beginning at zero, it has not been established to what extent the frequency of cancer rises in response to increasing doses of a carcinogen.

In the NCTR study of 2-acetylaminofluorene, the number of liver tumors in mice rose in linear relationship to the dose at all levels. But bladder tumors were nonlinear, rising at a lesser rate than the increase in dosage. In other carcinogens it is possible that the frequency of cancer might increase at a greater rate than the increase in dosage. In predicting risks to human beings based upon animal studies there are further uncertainties, especially in the low dosage range. A carcinogen that is weak in a test animal may be stronger in humans, or vice versa. Furthermore, the U.S. population is large, diverse, and genetically heterogeneous with apparently differing susceptibilities to cancer. Most important, human beings are exposed to a much greater variety of possible carcinogens than are pure-bred animals kept under controlled laboratory conditions. It is difficult to predict the possible synergistic effects of the many and various chemicals to which diverse human beings are exposed, compared with laboratory results for only one substance to which genetically pure mice or rats are exposed.

If interactions between various substances are considered—for instance, smoking combined with alcohol, smoking with asbestos, smoking with air pollution, and smoking with uranium ores—the usual scientific models for estimating cancer risk for a single factor may not be accurate.

SHORT-TERM TESTS FOR CANCER

A typical test of a chemical for carcinogenicity involves the use of at least 300 mice and 300 rats, two groups of 100 (50 males, 50 females), each receiving different doses of the chemical; a control group of 100 of both sexes; and sometimes another group receiving a dose of a known carcinogen. Such a test costs $200,000 to $400,000 and takes from 3 to 5 years to perform.[74]

Progress has been made in developing suitable short-term tests, which might cost as little as $1,000 per chemical. These tests include transformation of normal cells to cancer cells in culture; DNA damage and repair tests in animals or in cultured cells; and tests for mutations in bacteria in fruit flies, in microorganisms, or in cultured cells.[75] These tests are not yet sufficiently validated for identifying carcinogens without other data, but they do provide a basis for screening

compounds for possible carcinogenicity. They are used in regulation as supportive evidence for carcinogenicity, with data from epidemiological studies or animal tests, and can be used to assign priorities for more complete testing.[76] Scientists hope that these relatively quick and inexpensive tests can eventually be used to predict which chemicals are carcinogenic, without subjecting chemicals to long-term bioassays in animals.

An essential step for developing fully validated short-term tests is understanding certain basic biological and biochemical mechanisms by which cancer is induced. According to one theory, cancer induction is due to latent viruses; another suggests a permanent alteration of genes; a third points to the alteration of the transmission of genetic messages to cells and tissues rather than an actual change in the genes.[77] Mounting evidence indicates that carcinogens in the nucleus of cells target their attack against the DNA—the component of chromosomes that carries genetic instructions.[78] Once the induction is understood, not only definitive tests for carcinogens, but also true cures for cancer—not the palliatives of surgery or imprecise chemotherapy—may be possible.[79]

LOW-LEVEL RADIATION

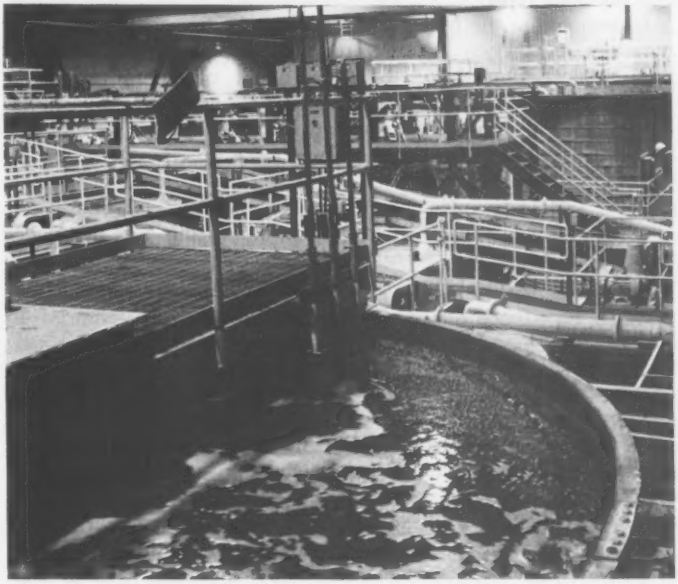
Controversy over the risks from low-level radiation continued without resolution in 1978 and early 1979. As scientists debated the highly complex question of risks, more and more people began seeking compensation from various government agencies for radiation damages they claimed to have suffered in the past.

On the scientific level, the sharp differences among specialists remained. Several technical reviews of the low-level radiation issue were completed and a number of institutional changes recommended. At the same time there was an intensification of research to help clear up the uncertainties,[80] and the Nuclear Regulatory Commission proposed to reduce worker exposure to radiation.[81]

SCIENTIFIC STUDIES

Two reports on low-level radiation were released by the National Academy of Sciences in 1979. The first, a critical review of the literature on the risks associated with nuclear power, observed without any conclusions that there is a "considerable difference of opinion among experts as to the human response to a low dose of radiation."[82] In the opinion of some scientists, present federal radiation standards to protect workers are inadequate and should be tightened, perhaps reduced to one-tenth the present allowable levels. Others say that all evidence shows the present standards to be safe. The report also noted a wide difference of expert opinion on the hazard posed by radioactive radon gas released by uranium ore tailings. Because the principal source of radon in the tailings has an 80,000-year half-life,

Tailings of uranium ore from mine (above) and mill (below) contain radioactive materials—radium and radon gas—with a half life of 80,000 years. Risks from the wastes are uncertain but can be reduced by suitable burial. Photographer: James J. MacKenzie.



many scientists believe the cumulative radiation dose could be quite significant. Others counter that it could be small, depending on the inadequately researched time-scale for reburial of the tailings by natural geological mechanisms. The report noted that nearly all scientists agreed that risks can be reduced by suitable burial of wastes or other disposal schemes.

The second study was prepared for the National Academy of Sciences by its Committee on the Biological Effects of Ionizing Radiation.[83] After a thorough review of the various possible bases for estimating the effects of low-level ionizing radiation on human populations, the committee selected one using a linear extrapolation from known high-level exposure data. If the data show that a certain high-level amount of radiation causes 100 cancer cases in a given population, and one-tenth as much causes 10 cases in that population, then the model predicts that one-hundredth as much will cause one cancer, although the amount of radiation is so low that its effects cannot be measured with great certainty. This model assumes that there is no threshold below which radiation ceases to have adverse effects on humans. (See earlier discussion of threshold levels of exposure for carcinogens and the uncertainties in extrapolation.) The majority of the committee recommended using the linear hypothesis to predict risks at low levels, but several members dissented, stating that in their opinion it overstated the number of cancers due to low-level radiation. After the report was released, additional committee members asked for revisions; a new six-member committee was appointed to resolve the issues and incorporate the dissenters' views into the main report.[84]

In response to the public controversy and concern over low-level radiation, several new research programs were started. Among them is a project funded by the Department of Energy to study further the effects of low-level radiation exposures on workers in six Navy shipyards and one private shipyard, all of which were or are involved with the Navy's nuclear submarine program.[85] A total of 250,000 workers, including some employed in the early 1950s, will be studied. The Department of Health, Education, and Welfare also announced it will expand its research efforts in this area by undertaking detailed studies of health effects on people exposed to small radiation doses at the Three Mile Island accident.[86]

LITIGATION

At the same time, hundreds of people around the country who had contracted one form of cancer or another and who thought the federal government's nuclear weapons testing program in the 1950s and 1960s was responsible were filing claims or filing suit against several government agencies. Many of the claimants were U.S. Army veterans who were required to stand as close as a mile from the detonation site of nuclear warheads in the Nevada desert or on Pacific islands. Others, who had been positioned at greater distances at the moment of explosion, were then helicoptered to the blast site and

ordered to run over ground that was still physically hot. According to the *New York Times,* from 1951 to 1962 about 80,000 servicemen witnessed nuclear bomb detonations at distances of between 1 and 14 miles.[87]

It is unclear whether the dose these servicemen received would be rated as high-level or low-level radiation because the Army kept very inadequate records on exposure. Although some of the G.I.s felt nauseated immediately after the blasts, the leukemia and other cancer cases did not begin showing up for 20 years or more. Now, more than 500 former military men have filed claims seeking compensation from the Veterans Administration (VA). The VA has turned down 92 percent of all bomb-related claims because it will only accept symptoms, diseases, or injuries that turn up during service or within one year of discharge.[88] A Supreme Court ruling in 1950 prevented veterans from appealing any VA final ruling to the courts.[89] (Some of the veterans are taking that route anyway, in hopes of changing the precedent.)

Another group of citizens—about 600 residents of Nevada, Arizona, and Utah called the Committee of Survivors—have filed suit against the Department of Energy (DOE) for damages they claim to have suffered due to radiation that drifted from the Nevada testing grounds over their towns. DOE was named in the suit because it has absorbed the old Atomic Energy Commission, the agency responsible for the testing, and also responsible for telling the residents at the time that the radiation was completely safe. One woman in St. George, Utah, has counted 8 cancer deaths and 29 cancer cases within a 1-block radius of her home.[90]

Unfortunately, from an epidemiologial point of view there is little to be learned from these tragedies. The records kept by the Atomic Energy Commission were so poor that today's researchers face an almost impossible task in going back and determining the level of radioactive dose received by the people in Utah, Nevada, and Arizona and correlating it with the incidence of cancer today.

In June 1979, a radiation research committee, established by the President nearly a year earlier, suggested major changes in the federal government's regulations on research and control of low-level radiation.[91] The task force recommended establishing a radiation council, composed of high-level officials from the major agencies concerned, to formulate radiation protection policies and coordinate activities. It also recommended that a separate interagency radiation research committee be established, to be chaired by the National Institutes of Health. The task force noted that separation of the research committee from the policymaking council would assure the committee's independence, but recommended coordinating their activities.

Meanwhile, in February 1979, the Nuclear Regulatory Commission (NRC) proposed to reduce allowable occupational radiation doses to workers in licensed commercial nuclear activities from 12 rems in 1 year to a quarterly dose limit of 3 rems and an annual dose of 5 rems to the whole body. A rem is a standard measurement of

biological damage done by radiation. It reflects the fact that some types of radiation produce more biological damage than others for a given amount of absorbed energy (rad). The NRC proposal followed recommendations by the International Commission on Radiological Protection.[92] NRC also directed that hearings be held in the spring of 1979 to consider the adequacy of present occupational radiation dose standards.

DIOXINS

EPA SUSPENSION OF 2,4,5-T

On February 28, 1979, the EPA Administrator issued emergency orders suspending the registration of certain uses of two related herbicides—2,4,5-trichlorophenoxyacetic acid (2,4,5-T) and 2-(2,4,5-trichlorophenoxy) propionic acid (Silvex).[93] These are two of the most widely used herbicides in the United States, and the suspension covered close to three-quarters of their uses. The use of both herbicides in forests, pastures, and along right-of-ways was halted. The use of Silvex in the home and garden, in waterways and ditches, and for commercial and ornamental purposes was also suspended. Similar uses of 2,4,5-T had been prohibited by the U.S. Department of Agriculture (USDA) in 1970.

EPA's action on Silvex and 2,4,5-T was unprecedented; no substance had previously been suspended under emergency provisions. The action was based on human evidence and animal tests, both indicating that 2,4,5-T, Silvex, and their common contaminant, 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), generally known as dioxin, have the potential for causing miscarriages, birth defects, and other adverse reproductive effects. Although manufacturers have attempted to reduce the presence of dioxin in their commercial products, it is currently deemed impossible to avoid at least some contamination. TCDD is formed during the manufacture of other chemical products as well, perhaps most notably 2,4,5-trichlorophenol, an ingredient in the production of the antiseptic hexachlorophene.[94]

Research since 1970 has shown TCDD to be one of the most toxic substances ever studied. Fetotoxic effects have been seen in rats at levels of exposure at least as low as .01 micrograms per kilogram of body weight, or 10 parts per trillion (ppt). In monkeys, toxicity to the offspring of treated animals has been seen at doses as low as 2.5 ppt. TCDD has also been shown to be carcinogenic to test animals at doses as low as 2.2 parts per billion.[95]

Many experts had advocated the suspension of 2,4,5-T for several years and urged action in the remaining uses after the USDA cancellation. However, EPA could not document residues of TCDD in human tissue connected with uses such as right-of-way or forest spraying. A U.S. District Court enjoined EPA from further action on the basis of the information available at that time and the 8th Circuit Court of Appeals remanded the decision to EPA.[96] The

agency established a large-scale monitoring project, the Dioxin Implementation Plan, to develop a method of analysis for TCDD residues, and to analyze human, animal, and environmental samples. Included for analysis were samples of drinking water, soil, and sediment, and samples of mothers' milk from the Pacific Northwest where forest spraying with 2,4,5-T and Silvex is substantial. These analyses were near completion, but until results were available, EPA was cautious and did not further restrict uses of the herbicide.

In April 1978, EPA initiated public comment on 2,4,5-T by issuing a Rebuttable Presumption Against Registration.[97] During the comment period, eight women from Alsea, Ore., wrote to EPA,

By emergency order, EPA halted the spraying of forests, pastures, and rights-of-way with the herbicide 2,4,5-T.

reporting that all had suffered miscarriages shortly after the herbicide had been sprayed nearby. The news prompted EPA's Office of Pesticide Programs to sponsor a study of spontaneous abortions in an effort to establish an exposure link.[98]

Looking at a 6-year period between 1972 and 1977, the investigators found that spontaneous abortions occurred more frequently in the Alsea area in the summer than during the rest of the year. In the control area, a nonsprayed portion of eastern Oregon, miscarriages dropped during the summer. The investigators also found a significantly higher overall index of miscarriages in the study area regardless of season.

Although by its study design the Alsea investigation could not provide conclusive evidence of increased risk, it supplemented the large body of data from animal tests indicating that 2,4,5-T and Silvex contaminated with TCDD, and TCDD itself, can produce fetotoxic, teratogenic, and other reproductive effects. The results were strong enough—along with the inference of exposure from the manner of use—to provide a reasonable suspicion that the seasonal incidence of miscarriages was being influenced by the springtime spraying of 2,4,5-T. These results, learned by EPA less than a month before commencement of the 1979 spraying season, caused enough concern that the agency used the emergency suspension provision for the first time ever, until a full risk-benefit evaluation could be completed.

Immediately, the Dow Chemical Company, the principal manufacturer of 2,4,5-T, and 10 other firms or groups went to court to prevent EPA's action. However, on April 12, 1979, a U.S. District Court judge, after hearing evidence from both sides, concluded that the agency's action was not groundless or in clear error and upheld the suspension.[99]

Meanwhile, Dow had begun an investigation several months earlier into the distribution of dioxin in the Tittabawassee River, which flows past Dow's Midland, Mich., plant. According to the company, results of the study suggested that dioxins are not escaping into the river, and furthermore that dioxins are a bypoduct of all types of combustion and are found nearly everywhere—from rural areas to the hearts of central cities.[100] However, other scientists pointed out that although dioxins did appear to show up in many different places, not all of them were the highly toxic 2,3,7,8-TCDD variety.[101] Furthermore, the dioxin levels in the Tittabawassee River and around the Dow plant are hundreds or thousands of times higher than elsewhere.

After losing the effort in court to lift the suspension, Dow and the other registrants exercised their appeal rights under federal pesticides law and requested an administrative hearing to consider the suspension. EPA convened a hearing panel, but shortly thereafter Dow and the other registrants withdrew from the suspension hearing and requested the commencement of expedited cancellation proceedings

in an attempt to settle the larger issue of a permanent ban by the 1980 spraying season. Consequently the suspension action begun in March is final.

The cancellation process is considerably more lengthy and detailed than the emergency suspension action. In suspending the registration of a pesticide, the agency must consider only short-term risks and benefits. Attention in the cancellation proceedings will focus less on the single Alsea study and more on the totality of information on exposure, risks, and benefits. The hearings will commence in the fall of 1979 and may last as long as 2 years. Some registrants of Silvex have agreed voluntarily to cancel their products for home and garden use. Chevron Chemical Company, US-Agrichemical, Lebanon Chemical Corporation, and J&L Adikes, Inc. will also assist in the retrieval and disposal of their Silvex home and garden products. Companies taking on these responsibilities are entitled to compensation under the pesticides law.

Not all uses of 2,4,5-T and Silvex were affected by the emergency suspension. The unsuspended uses, including 2,4,5-T use on rice and rangeland, continued under the intensive review.

VETERANS' EXPOSURE TO DIOXINS

The Veterans Administration has been drawn into the controversy regarding the long-term health effects caused by dioxins, as a growing number of Vietnam veterans seek medical treatment or disability benefits for unusual or unexplainable illnesses. A class action lawsuit has been filed in their behalf. At issue is whether Agent Orange, a 50:50 mixture of technical grades of 2,4-D and dioxin-contaminated 2,4,5-T, which was used to destroy food crops and defoliate forests that provided cover for combatants in Vietnam, is responsible for any harm suffered by the veterans. More than 11 million gallons of Agent Orange containing approximately 50 million pounds of 2,4,5-T, 350 pounds of dioxin, and unmeasured other impurities were sprayed in Vietnam.[102]

In 1970, after a National Academy of Sciences review concluded that 2,4,5-T was a teratogen (causing birth defects) in animals,[103] and after the Departments of Health, Education, and Welfare; Interior; and Agriculture took action to limit the domestic use of 2,4,5-T, the Department of Defense discontinued the use of Agent Orange.[104] The VA estimates that hundreds of thousands of Vietnam veterans may have been exposed to the herbicide.

Controversy began in early 1978, when a VA claims representative made public the unusual disabilities that were increasingly being presented by Vietnam veterans, for whom the common factor was exposure to Agent Orange.[105] Fourteen months later, in May 1979, the VA had not yet conducted a public review of the available information relating to the long-term health risk of Agent Orange, or more particularly, dioxin exposure. This fact prompted the filing of a class action lawsuit against the VA on behalf of the exposed veter-

ans.[106] The disabilities alleged to be related to Agent Orange exposure—which include skin discolorations, muscle spasms, nervousness, numbness of the extremities, liver dysfunction, cancer, and birth defects—are not new to the VA as disabilities. However, no one before had claimed that such disabilities arose from an in-service exposure to an environmental toxin.

The litigation seeks to require the VA to address the possible connection between exposure to Agent Orange and reproductive and other health effects in veterans. In addition, the suit, if successful, would force the VA to consider the effects of an exposure with long latent periods. Currently, to receive compensation, a veteran must have experienced symptoms, diseases, or injuries during service or within one year of discharge. (This rule is similar to the VA rule on claims for radiation exposure.)

Meanwhile, the Air Force announced it will conduct a study of 1,200 men who were involved in "Ranch Hand," one of the major herbicide-spraying projects in Vietnam. The study, to extend over 6 years, will be performed by the School of Aerospace Medicine in San Antonio.[107]

STREAMLINING PESTICIDE REGISTRATION

Regulation of pesticides has been at the forefront of environmental concerns since the mid-1960s. In 1978 Congress passed, and President Carter signed, amendments to the Federal Insecticide, Fungicide, and Rodenticide Act of 1947 (FIFRA), as amended in 1972. The amendments overhauled the 1972 version of FIFRA and were designed to remedy previous inequities and simplify the regulation of pesticides.[108]

The federal government's first attempt to regulate pesticides under FIFRA, which remained in effect for 25 years, focused on proper labeling and efficacy of pesticides shipped in interstate commerce.[109] FIFRA was radically amended in 1972 to strengthen the government's legal authority to regulate pesticides, and to make more explicit requirements for adequate premarket testing of new products for adverse health and environmental effects.[110] EPA was also charged with re-examining all previously registered products in order to assure they met the new standards.

Registration under the 1972 law was cumbersome and slow. Every new application was subject to an individual review; each of the 40,000 or so pesticide products on the market was to be re-registered product by product. In addition, a double standard was established in implementing the law because registrants of new products had to meet more stringent data requirements than those for existing pesticides—even though the old products may have been similar or identical to the new ones. When new manufacturers sought to be added to the list of registrants for some pesticides, litigation arose over the use by one company of previous data on a product generated by another company.

The 1978 Act, signed into law on September 30, recognized and remedied the inequities and provided far-reaching changes to simplify the regulation of pesticides. Under the new law, the following changes were made:

- EPA was granted authority to streamline the entire registration program by using generic standards for pesticide ingredients for the first time. In other words, the agency can now conduct a series of one-time scientific reviews on a chemical-by-chemical basis, rather than the old product-by-product approach, for both registrations and re-registrations.
- For applications of new chemicals—as an incentive to develop complete data—EPA can grant to a company exclusive use of the data developed for a registration for 10 years; for existing registrations, data on a pesticide can be used by any new registrant, provided the company is willing to share in the cost of generating the data.
- EPA was granted new flexibility to register pesticides on a "conditional" basis, i.e., on the condition that additional information will be forthcoming in the future.
- The public now can gain access to the basic health, efficacy, and environmental data for pesticides upon which decisions are based. At the same time companies' traditional and bona fide trade secrets—information on the industrial process and yield, information on sales, and so on—are protected.
- Finally, the law permits EPA to waive the need for presentation of efficacy data for pesticides, thus reducing data requirements for industry and allowing EPA to devote its resources in health-related issues. When no significant public health concerns are involved, chemical companies no longer need to show EPA that their products are effective against pests, weeds, or rodents.

Regulations to implement conditional registrations, efficacy waivers, and compensation were issued in May 1979.[111] As of June 1, 1979, EPA granted more than 300 conditional registrations for products containing old chemicals, and seven conditional registrations for brand new chemicals (most of them to combat cotton pests for the 1979 growing season).[112] Generic registration standards, which involve almost 600 different chemical ingredients, have begun, but the whole review process is expected to take more than 10 years to complete.

TSCA IMPLEMENTATION

The Toxic Substances Control Act,[113] passed by the Congress in 1976 after 6 years of effort, represents one of the most far-reaching, comprehensive, and complex regulatory programs ever attempted by the federal government. The potential impact of toxic substances on the general public is tremendous, with more than 4 million chemical

substances in existence, tens of thousands in commerce, and thousands of new ones introduced each year.

Most of these chemicals are not harmful under normal conditions of use, and many are essential to public health and welfare. The philosophy of TSCA is that inadequately tested chemicals should not enter the marketplace and be dispersed into the environment, and the effects of existing chemicals should be reviewed so that unreasonable risks to human health or the environment may be removed.

TSCA requires that an industry notify EPA ahead of time when commercial production is planned for any new chemical, or for any significant new use of an existing chemical. The agency then may require further testing of the chemical, take a variety of regulatory actions, or do nothing, thus allowing manufacture to proceed. The law also requires EPA to publish an inventory of existing chemical substances, to require industry to keep records and to report information relevant to determining the potential risks of chemicals, and to require industry to develop data on the health and environmental effects of the chemicals they manufacture if they seem to present an environmental risk, or if there are little data known about them. EPA is authorized to take any appropriate action against an existing chemical that is found to be an unreasonable threat to the environment or public health.

Most of this agenda still has to be carried out. In 1978, and the first half of 1979, EPA took the following steps toward implementing TSCA:

The Chemical Inventory The initial inventory of chemical substances used in commerce and subject to TSCA, consisting of some 43,000 unique formulations reported by nearly 7,400 manufacturers and importers, was published on June 1, 1979.[114] The original TSCA deadline for publication was October 1977. The inventory data base includes 1977 information on chemical production volume by sites. Because some of the production information is considered confidential under the law, EPA will aggregate data for public reports. Chemical processors, users, and importers will contribute to a revised inventory through a second round of reporting, adding substances that were not on the initial inventory. The revised inventory is expected to be published in 1980. All substances not on the inventory will be considered "new," and therefore subject to the premanufacture notification requirements.

Premanufacture Notification In January 1979, EPA proposed rules under which manufacturers must notify the agency before they produce new chemical substances.[115] By law [116] the premanufacture notification program went into effect July 1, 1979—30 days after publication of the inventory of existing substances. Manufacturers were not required to follow the specific provisions of the EPA rules until these are made final; however, in the meantime, under an EPA Interim Policy,[117] they must adhere to the premanufacture notification provisions in the statute.

Under the proposed rules, any manufacturer or importer of a "new" chemical substance—one that is not on the TSCA inventory—must submit information, including all available testing and exposure data, at least 90 days before commencing manufacture or importation. If EPA takes no action, manufacture may proceed. However, if the substance poses an unreasonable risk, the agency has the authority to take a wide variety of regulatory actions, ranging from special labeling and required protective measures, to limitations on production, use, or disposal. EPA may also act if the available information does not permit a proper evaluation of the risks.

The complexity of TSCA's policy issues can be seen by the difficult decisions EPA had to make on the proposed rule: how much and what kind of information manufacturers must submit in their premanufacture notices; how to obtain information without stifling innovation or endangering confidentiality; and on what basis insufficient information would render premanufacture notices invalid (i.e., unacceptable because they contain too little information).

Industry was highly critical of the proposed premanufacture notification rules, arguing that EPA wanted too much information and that the requirements went beyond what the law required and would drastically limit innovation in the chemical industry. Companies particularly disliked the requirement that they attempt to obtain from their customers information on how the latter would use the new chemicals. The companies also asserted that EPA's estimates for the costs of premanufacture notification were low.

The agency pointed out that customer-use information is indispensable for determining the manner in which workers and consumers might be exposed to chemicals. In addition, EPA reiterated the need for minimum mandatory information and setting up the category of an "invalid" notice if this minimum is not attained. The agency claimed the reporting costs were small compared to the costs of developing new chemicals, and that they were dwarfed by the potential costs of damage from chemical hazards. Industry's costs, EPA said, would be greater if an unassessed chemical reaches the market and then has to be withdrawn or controlled than if the risks are identified at an early stage. However, the agency agreed to consider worthwhile alternative workable approaches to the proposed premanufacture rules and notice forms, and promised to consider less detailed reporting requirements (including shorter forms) for low-volume substances.[118]

Another controversy centered on testing guidelines for new chemical substances. The issue was whether EPA should issue guidelines to industry explaining what type of testing and test results would satisfy the agency's information needs for premanufacture notification and if so, how specific the guidelines should be. EPA is not permitted under TSCA to issue testing *rules* requiring certain tests for *all* new chemicals, although certain new or existing chemicals may be included in specific testing rules; see the section on testing priorities below. The technical, economic, and policy considerations in this

controversy were so complex that EPA published in the *Federal Register* a detailed "Discussion of Premanufacture Testing Policy and Technical Issues" for public comment.[119]

Testing Standards In May 1979, EPA issued its first proposed testing standards. These standards describe the methodologies that industry must use in testing for given effects when EPA requires specified chemicals to be tested for those effects.[120] These first proposed testing standards were for oncogenicity (tumor production), chronic toxicity, combined chronic health effects, and "Good Laboratory Practices" for health effects testing (i.e., the actual laboratory procedures used to test for health effects). In July 1979, EPA proposed a second set of health effects testing standards. These were for tests to determine acute toxicity, subchronic toxicity, reproductive and teratogenic effects, and for metabolism studies.[121] EPA will propose environmental test standards in late 1979, covering the ecological effects and environmental fate and transport of chemicals.

Testing Priorities With more than 43,000 chemicals under TSCA's jurisdiction and with the nation's limited testing resources, the job of selecting substances for further testing is one of Herculean proportions. To help EPA with this task, TSCA created the Interagency Testing Committee (ITC), composed of members from eight federal agencies.[122] The ITC's charge is to recommend chemicals for priority consideration for testing under TSCA. Since October 1977, the ITC has published four reports recommending testing for a total of 33 chemicals and groups of chemicals.[123] TSCA requires EPA to respond to the ITC's recommendations within 12 months: either to initiate rulemaking to require the industry to conduct tests, or to explain the reason for not doing so. In response to the ITC's first two reports, EPA explained that it was still in the process of evaluating the recommended chemicals and that proposed testing rules could not be issued until the relevant testing standards had been proposed.[124] This response did not satisfy the Natural Resources Defense Council, which filed suit asserting that EPA had unlawfully delayed requiring manufacturers to test high risk chemicals.[125]

Risk Assessment Risk assessment is the systematic evaluation of a chemical's hazard and exposure potential, and the resulting risks. EPA has developed a multistaged process of risk assessment for identifying and evaluating the chemical substances of highest concern from among the tens of thousands under TSCA's purview. After initial selection of chemicals for review, based on very general information about a substance's characteristics, production, potential for significant exposures, and effects, EPA will proceed step by step to progressively more intensive assessments.[126]

As of June 1979, EPA had completed preliminary assessment of 65 chemicals and more detailed reviews of another 19 chemicals. Of those, three had already progressed to the most advanced stage of in-depth review; these were asbestos and chlorofluorocarbons (both of which had already been partly restricted but were still used for certain purposes), and nitrilotriacetic acid (NTA).[127]

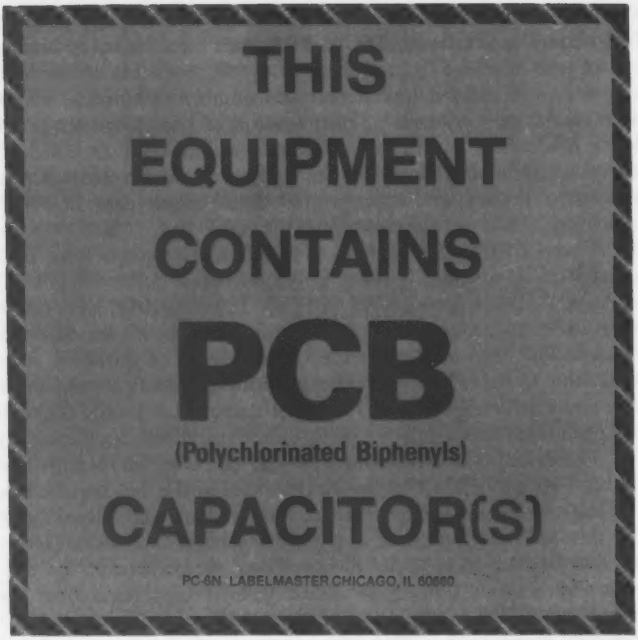
To determine whether the risks are "unreasonable" for purposes of regulatory action under TSCA, EPA must consider many factors, such as type of effect (e.g., chronic or acute, reversible or irreversible); degree of risk; characteristics and number of humans, plants, and animals, or ecosystems at risk; amount of knowledge about the effects; availability of alternative substances and their expected effects; magnitude of the social and economic costs and benefits of possible control actions; and appropriateness and effectiveness of TSCA as the legal instrument for controlling the risk.

PCBs and CFCs Two groups of chemical substances have been regulated to date under TSCA: polychlorinated biphenyls (PCBs) and certain chlorofluorocarbons (CFCs). In April 1979, EPA issued final rules [128] prohibiting the manufacture of PCBs, a class of industrial chemicals that have been used for a variety of purposes, from ink solvents to fluids in electrical transformers and capacitors. Processing and distribution of PCBs and uses that are not totally enclosed were prohibited after July 1, 1979, unless specifically exempted by EPA. The rules for marking and disposing of PCBs, which EPA had issued in February 1978,[129] were incorporated in the new regulations, including the detailed requirements for servicing and disposing of PCBs that are totally enclosed in transformers and capacitors. (However, the disposal rules apply to only about 60 percent of the estimated 750 million pounds of PCBs still in use; regulating the disposal of PCBs in small appliances and capacitors, such as household fluorescent lights and television sets, was considered impractical.)

EPA's final rule prohibiting the manufacture or use of certain chlorofluorocarbons (CFCs) for all nonessential aerosol applications became effective October 15, 1978. CFCs were used as propellants in aerosol cans, such as deodorants and hair sprays, but studies in the mid-1970s showed that CFCs would deplete the stratospheric ozone layer that shields the earth from harmful radiation from the sun. EPA's final rules were issued jointly in March 1978 with the Food and Drug Administration.[130] The Consumer Product Safety Commission, although an active participant, did not issue final rules, because consumer aerosol products using chlorofluorocarbons could be covered under the EPA and/or FDA regulations.

However, not all uses of CFCs have been prohibited. The need for additional regulatory action on the remaining uses—such as in refrigerators and air conditioners and in the manufacture of foams and solvents—is under study. EPA and other federal agencies continue to participate in international research programs to study CFCs,[131] as mandated by the Clean Air Act amendments of 1977,[132] under which any future regulatory action will occur.

Asbestos EPA is giving attention under TSCA to asbestos, the ubiquitous fireproofing and insulating material that has been found to induce several different respiratory diseases including asbestosis, mesothelioma, and lung cancer. The spraying of asbestos onto structures had previously been regulated under the Clean Air Act in 1973



Under EPA rules, electrical equipment containing highly toxic PCBs must be clearly marked. Manufacture of these chemicals is now prohibited.

and 1978, but the vast amount of material already in dwellings constitutes a continuing threat to the general public, especially in deteriorating structures. Of particular concern is the exposure of school children. In 1979, EPA and the Department of Health, Education, and Welfare initiated a nationwide voluntary program to identify and correct asbestos problems in schools, including providing training and technical assistance. The Environmental Defense Fund (EDF) initiated a suit to require EPA to take regulatory action, including mandatory inspection, after their earlier petition was denied by EPA. In July 1979, EPA reversed its decision and granted the EDF petition, publishing a notice of intent to develop rulemaking.[1,3] Congress is considering various legislative proposals to provide funding for asbestos control either with federal money or through provisions for industrial liability.

Other Existing Chemicals To date EPA has been concentrating its rulemaking efforts on new chemicals, rather than existing ones. The regulations on PCBs and CFCs, the asbestos program, and the risk assessment activities reported above are the only principal actions that have been directed at existing chemicals.

The philosophy behind this approach to implementing TSCA is that time and resources are best used at the present time in the vast

task of gathering improved information about chemical hazards and in preventing the introduction of new hazardous chemicals before their widespread production and use makes regulation substantially more difficult. EPA also points out that other EPA regulatory programs—dealing with air and water pollution, solid wastes, and pesticides—have considerable authority to regulate existing toxic chemicals, and that other agencies, such as the Occupational Safety and Health Administration, the Food and Drug Administration, and the Consumer Product Safety Commission have regulatory authority for hazards in the workplace, in food and drugs, and in consumer products.

EPA plans to give existing chemicals more regulatory attention once all of the TSCA provisions for reporting, testing, and control are operational. EPA will employ these provisions, singly and in combination, to eliminate or reduce "unreasonable risk of injury to health or the environment" stemming from new and existing chemicals.

Data Systems Work is continuing on EPA's Chemicals in Commerce Information Systems (CICIS) for data submitted to EPA under TSCA. This computerized system will allow users to search for and sort data to fit their analytical needs. The public data file for the initial inventory portion of CICIS is expected to be available for use during 1980.

CICIS will be a component of a federal network of chemical data and information systems. This Chemical Substances Information Network (CSIN) is being developed as an interagency project to meet the needs of users, both in and out of the government. Some other components of CSIN will be operational sometime during 1980 and 1981; development of the full network will continue intensively.[184]

Public Participation As in most federal regulations, EPA provides opportunity for public testimony during rulemaking hearings for toxic substances and public comment on proposed rules. In addition, EPA is undertaking three activities to promote further involvement in toxic substances control activities. The 16-member Administrator's Toxic Substances Advisory Committee, representing a broad variety of interests, met six times during the past year, advising EPA on several topics, including overall implementation of TSCA, premanufacture review, and risk assessment. EPA also awarded a grant to 25 nonprofit groups in New York and New Jersey for a pilot program to find ways for increased citizen participation. The agency is also developing rules to compensate participants in rulemaking hearings who can make a substantial contribution but who cannot otherwise afford to take part.[185]

The International Aspect The debate over TSCA's implementation is not confined to the domestic arena. International issues are also controversial. With each new proposed rule under TSCA some foreign governments and representatives of the foreign chemical in-

dustry expressed concern. There were allegations that nontariff barriers to international trade would result from the rules, especially the one for premanufacture notification requirements. Countries within the European Economic Community were particularly troubled because the TSCA approach to testing and reporting was different from what they were considering.

The United States continued to work toward resolution of these questions through active participation and leadership in the chemical activities of the Organization for Economic Cooperation and Development (OECD). Harmonization of approaches to toxic substances control is of particular interest. Major emphasis under the OECD chemicals program has been on the development of mutually acceptable testing standards and procedures. The United States has contributed significant support to this program and to the resolution of related issues: development of a glossary of key terms, consistent standards for laboratory practices, policies relating to the sharing of data and protection of confidentiality of data, and economic and trade impacts of chemical control.

The views of other nations and international organizations have been actively solicited in every aspect of TSCA implementation. International consistency is regarded as highly desirable so long as it can be achieved in a manner compatible with U.S. law and obligations to protect U.S. citizens and the environment from unreasonable chemical risk. As more nations pass comprehensive legislation on risks from chemical substances, achievement of international agreement on compatible approaches becomes both more difficult and more urgent.

WORKPLACE HAZARDS

Recognizing that protection of workers in their working environment is essential, Congress passed the Occupational Safety and Health Act in 1970.[136] Environmental hazards in the workplace cause 14,000 on-the-job deaths annually, and 2 million injuries.[137] It is estimated that at least 100,000 deaths per year are attributable to occupational diseases and illnesses from exposure to chemical and physical hazards.[138]

From its inception, the Occupational Safety and Health Administration (OSHA) found itself in the center of controversy between unions and public interest organizations, which pressed for strict worker protection rules, and industry, which opposed spending funds it claimed were nonproductive. Unfortunately, in its early years, the agency developed a reputation for nitpicking regulation instead of effective protection of health and safety.

Beginning in March 1977, under a directive from President Carter, the agency redirected its policies to emphasize prevention of occupational disease, to concentrate efforts on high-risk industries, and

to eliminate useless regulation and paperwork.[139] In the past year, OSHA:

- Removed or modified more than 900 safety standards that were not essential to worker protection and had needlessly antagonized employers;[140]
- Began to devote 95 percent of inspections to the industries with the most serious workplace hazards;
- Completed health standards on cotton dust, benzene, and lead exposures;
- Proposed regulations, expected to be final by the end of 1979, to require employers to open medical records, when they exist, to workers; and
- Proposed to reduce the record-keeping duties of many employers.

The three new health standards raised some significant issues.[141]

COTTON DUST

Cotton dust is a serious problem in the textile industry and various related enterprises because it can cause a degeneration of the lungs known as byssinosis, or brown lung. An estimated 35,000 textile workers, primarily in the South, currently suffer from brown lung disease. The cotton dust standard is intended to protect workers from byssinosis and other acute and chronic respiratory diseases.

Under the standard, workers in yarn manufacturing may not be subjected to cotton dust in concentrations greater than 200 micrograms of fibers per cubic meter of air. Workers involved in slashing and weaving, who have a lower prevalence of byssinosis, may be exposed to up to 750 micrograms per cubic meter. (Slashing involves dipping yarn in starches to keep it firm and even.) All other workers in the cotton industry and in nontextile industries that generate cotton dust (such as warehousing, reclaiming cotton waste, etc.) may be exposed to no more than 500 micrograms per cubic meter. Cotton ginning—where seeds are removed from the cotton bolls—was judged impossible to cover by a standard because it primarily involves an outdoor, open workplace. Instead, OSHA prescribed special work practices such as frequent equipment repair, careful housekeeping, medical surveillance, accurate record-keeping, and use of respirators.

During the Ford Administration, OSHA had proposed an across-the-board cotton dust standard of 200 micrograms per cubic meter, but the agency backed off when it was calculated that equipment costs alone to comply would total $2.7 billion. The Department of Labor then estimated that compliance with the new standard will cost industry $625 million for new equipment and $83 million in additional annual operating costs. As the standard was being developed, the Council on Wage and Price Stability determined that an additional $125 million could be saved by the substitution of respirators for engineering controls, but OSHA maintained that

Textile workers handling cotton wastes may contract brown lung (byssinosis) unless they are adequately protected from breathing cotton dust. Photographer: Pat Goudris.

engineering controls were so far superior in effectiveness that the extra cost was clearly worthwhile.[142]

OSHA promulgated the standard in June 1978 and gave the industry 1 year to develop a compliance program and 4 years to install effective engineering controls, such as ventilation. However several textile trade associations, mills, and the textile union took OSHA to court on various aspects of the standard, and in September 1978 the Circuit Court of the District of Columbia ordered the standard stayed.[143] A decision on the merits is expected by autumn 1979.

BENZENE

On March 13, 1978, OSHA published the permanent benzene standard, reducing the permissible exposure level from 10 ppm to 1 ppm on an 8-hour time-weighted average, with a 5 ppm ceiling

for any 15-minute period. The standard was based primarily on evidence in workers that exposure to benzene increases their risk of developing leukemia and a number of other serious, chronic blood disorders. Studies in animals had earlier provided inconclusive evidence that benzene induces cancer, but confirmed that it induced serious blood disorders.

Immediately upon the standard's publication, it was challenged in court by the American Petroleum Institute, most major oil companies, and several other industry groups on the ground that a reduction of exposure limits was not reasonably necessary to provide safe or healthful employment. The portion of the standard that banned skin contact to benzene was also challenged on the ground that it was not based on the best available evidence or the latest available scientific data.

In a major ruling, the Fifth Circuit Court agreed with the challengers and stayed the standard from going into effect.[144] The importance of this case is that it would require OSHA to quantify the exact benefits of regulation prior to the issuance of a health standard—that is, to quantify the human cancer risk associated with exposure to benzene at one part per million, despite the inherent difficulties of pinpointing cancer risks by means of human or other evidence. The opinion in this case is in conflict with rulings in three other Circuit Courts, and OSHA has petitioned the Supreme Court to hear the argument.[145] The Court has accepted the petition and the case is scheduled for the fall of 1979.[146]

LEAD

Lead is another serious occupational hazard. It can cause mental retardation, and a wide range of neurological, behavioral, and renal effects at both acute and chronic levels. Exposure to lead is an occupational hazard in at least 102 job categories.

On November 14, 1978, OSHA promulgated a lead standard of no more than 50 micrograms per cubic centimeter ($\mu g/cc$) of air in the workplace. The standard went into effect on March 1, 1979. However, both industry and the unions have challenged the standard, which is now partially stayed.[147]

The standard posed a particular problem to the agency because in many segments of the lead-using industry no technology presently exists to reduce worker exposure to the 50 $\mu g/cc$ level. OSHA's solution was to allow certain industries longer periods of time to comply with the standard. The primary smelter industries were given up to 10 years to comply. Respirators are a source of worker protection until engineering controls are available. However, because of discomfort and inefficiency associated with respirators, their use is likely to be a point of contention between workers and their employers.

A controversial aspect of the standard is "rate retention"—that is, if a worker must be moved to another portion of the operation be-

This worker, stacking lead plates in a battery plant, wears a protective mask to guard against breathing lead dust. Lead can cause mental retardation, or nerve or kidney damage. Photographer: Eric Poggenpohl.

cause of lead exposure, and the new job is normally paid at a lower rate, the worker's previously high salary must be retained. This unique provision provides an incentive to the industry to attain the standard as soon as it is feasible.

SOURCES OF LEAD IN BLOOD

New data suggest that lead poisoning in children is less prevalent than it appeared to be a few years ago. At the same time, lead in gasoline is emerging as an important source of high blood lead levels in children, perhaps surpassing lead in chipping, peeling paint.

In the 1960s, a number of acute lead poisoning cases in young children, mostly in poverty areas, raised intense public concern. Symptoms of lead poisoning are malaise, abdominal distress, neurological disorders, and in extreme cases, brain damage or death. The federal response to the cases of lead poisoning was a program to prevent exposure to lead-based paint,[148] which was believed to be the predominant source of lead poisoning. Blood lead levels reach their maximum in 2- to 4-year old children [149] when pica—the consumption of dirt or other nonfood materials—is more common than at other ages.

The idea is that children at these ages eat bits of material coated or contaminated with lead-based paint.

From 1971 to 1977, 1.8 million children were screened under the federal program, and about 7 percent were found to have elevated blood levels of lead. (Levels of 30 to 40 micrograms per 100 milliliters (ml) of blood are considered elevated. Acute symptoms generally occur at about 100μg/100 ml, but prolonged exposure at lower blood lead levels probably also causes damage.)[150]

Blood lead levels in children are generally dropping and fewer children have high levels. For example, in New York City in 1970, about 3 percent of the chidren screened had blood levels above 55 μg/100 ml. In 1976, the fraction of children with levels this high was 0.4 percent.[151] In New Haven, Conn. (where tested blood lead levels are exceptionally high because of the measurement technique), 23 percent of the children screened before 1971 showed blood lead levels above 40 μg/100 ml.[152] In more recent data, collected in 1974 to 1976, the fraction of children with similar levels dropped to 11 percent.[153]

Reported cases of death from lead poisoning have also greatly declined. On the basis of data collected in the 1960s, the Department of Health, Education, and Welfare estimated that 200 children died each year as a result of lead-based paint poisoning. But a telephone survey in 30 major cities, located in 22 states, revealed only five deaths due to lead poisoning in 1974, and one suspected case in 1975.[154]

Recent studies also cast doubt on the primacy of lead-based paint as a cause of elevated blood lead levels. One study found only a weak correlation between blood lead levels in 456 Pittsburgh children and the number of surfaces in their home covered with lead at levels considered hazardous (2mg/cm^2).[155] Figure 3–2 shows the results. Another study of 81 children in Cincinnati found that lead levels in blood did not reflect even the considerable levels of lead in paint in the children's homes.[156]

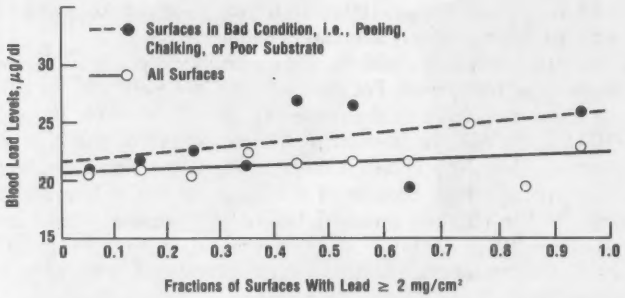
Still another example is a Philadelphia study, made in the 1960s, of 5,466 paint samples from the homes of children with elevated blood lead levels.[157] Only 67 percent of the paint samples had more than 1 percent lead. (Above the 1 percent level paint is considered hazardous.)

Table 3–7, presenting data collected through the federal lead-paint program, indicates that 40 to 45 percent of confirmed cases of elevated blood lead levels show no possible source of lead paint hazard in the home. The lead paint program has screened more than 80,000 dwellings as well as screening blood lead levels of nearly 2 million children.

The screening studies have also revealed that children's blood levels are highest in the months of July and August. Trying to explain this seasonal peak and to elucidate the inconclusive results of lead-based paint studies, research scientists sponsored by the Department of Housing and Urban Development compared blood lead

Figure 3–2

Correlation of Blood Lead Levels in Children with Fractions of Surfaces Within a Dwelling Where Lead Equals or Exceeds 2 mg/cm²



Source: U.S. Department of Housing and Urban Development, *Lead-Based Paint Poisoning Research* (Washington, D.C.: U.S. Government Printing Office, 1978), p. 88.

levels in New York with measured air-lead levels.[158] (The air-lead levels were measured at a single sampling station in Manhattan.)

As Figure 3–3 shows, although blood lead levels were higher in blacks than in Hispanics, both curves were generally similar to the curves for the air lead levels. The correlation between blood lead levels and lead consumed in gasoline is much stronger, as Figure 3–4 shows.[159] The peak blood lead levels of the summer of 1973 parallel a peak in usage of gasoline lead at the same time. Thus, consumption of gasoline lead appears to be an important source of lead in New York City children's blood. This correlation is not inconsistent with the idea that pica or other ingestion of lead-containing dust or dirt is important in raising blood lead levels. Lead in gasoline may con-

Table 3–7

Elevated Lead Levels and Dwelling Units Found With Lead Hazards

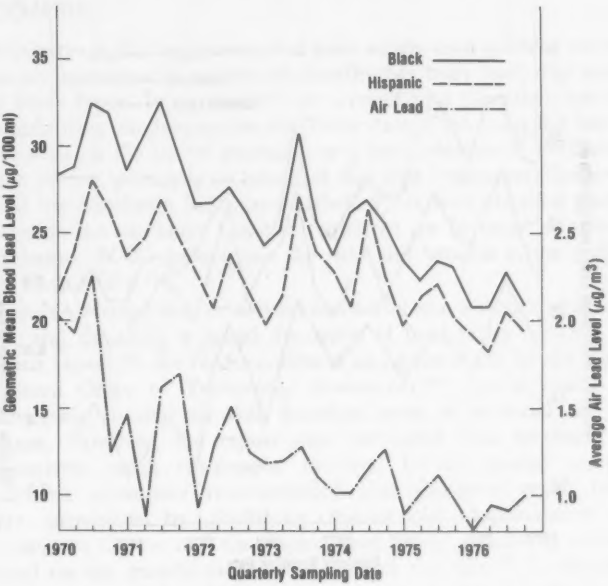
Fiscal Year	Children Screened	Children With Elevated Lead Exposure	Dwelling Units Inspected	Dwelling Units Found With Lead Hazards
1974	371,955	16,228[a]	23,070	13,742
1975	440,650	28,597[a]	30,227	17,609
1976 and transition quarter	500,463	69,131[b]	50,276	28,333

[a] Confirmed blood lead—40 μg/100 ml
[b] CDC Classes II–IV

Source: U.S. Department of Housing and Urban Development, *Lead Based Paint Poisoning Research* (Washington, D.C.: U.S. Government Printing Office, 1978), p. 72.

Figure 3–3

Comparison of Geometric Mean Blood Lead Levels in New York City Children to Air Lead Levels



Source: I. H. Billick, A. S. Curran, and D. R. Shier, "Relation of Pediatric Blood Lead Levels to Lead in Gasoline," unpublished.

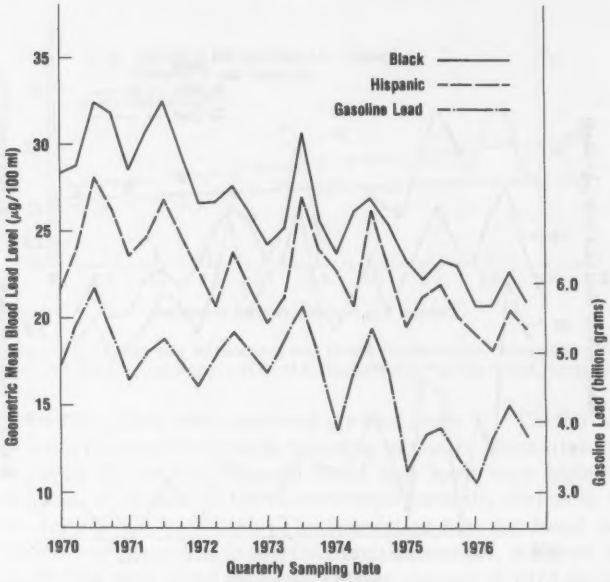
tribute not only to airborne lead but also to lead in dust or soil, which children may ingest. If data for consumption of lead in gasoline in New York, New Jersey, and Connecticut are added, the correlation with blood lead levels persists.[160]

Before we can be sure of the relative importance of lead-based paint and leaded gasoline in elevating the levels of lead in blood, more studies are essential. Other cities are under study. So far, Louisville seems to show a relationship between blood lead levels and consumption of lead in gasoline in Kentucky similar to that observed in New York.[161] Also soil lead levels were found to be a good environmental indicator of blood levels and a significant association was found between soil lead levels and the volume of traffic passing in the area.[162]

The phasedown of lead as an additive to gasoline began in 1973 and is continuing through October 1979. If the relationship between blood lead levels and leaded gasoline holds, the phasedown is likely to have a major impact on the lead burden of the entire population. A study now underway at the National Academy of Sciences, due to

Figure 3–4

Comparison of Geometric Mean Blood Lead Levels in New York City Children to Lead Consumed in Gasoline



Source: I. H. Billick, A. S. Curran, and D. R. Shier, "Relation of Pediatric Blood Lead Levels to Lead in Gasoline," unpublished.

be published in late 1979, will assess all the sources of lead in the environment.[163] In addition to EPA and OSHA, lead is regulated by four agencies under various statutes, as indicated in Table 3–8.

CARCINOGENS IN FOOD

Controversy continued this year over the federal government's responsibility to keep carcinogens out of foods. The ban on saccharin as a food additive, proposed 2 years earlier by the Food and Drug Administration (FDA) in compliance with the anti-cancer Delaney Clause, was again under consideration in the Congress. A controversial FDA study that indicated that nitrites commonly added to meats may cause cancer was under review. Also, FDA proposed to make a change in its manner of implementing the Delaney Clause with regard to animal drugs and additives to feed; the proposed change would redefine carcinogenic residues in food-producing animals in terms of the estimated level of risk that they pose.

The Delaney Clause, passed by the Congress in 1958, is a safety provision that applies to intentionally-added food additives and color-

ing agents. It provides that "no additive shall be deemed safe if it is found, after tests which are appropriate for the evaluation of the safety of food additives, to induce cancer in man or animal." [164]

SACCHARIN

Saccharin is the best known and most widely used artificial sweetener, an ingredient in toothpaste, mouthwash, baby food, diet soda, and other foods. In April 1977, as a result of a Canadian test in rats indicating carcinogenicity and other data, FDA proposed broad restrictions on the use of saccharin as a food additive.[165] Following public protest, primarily on behalf of diet soda consumers, Congress passed the Saccharin Study and Labeling Act that placed a moratorium on the saccharin ban and requested the National Academy of Sciences (NAS) to examine the risks and benefits to the public from the additive.[166]

The NAS issued two reports on saccharin, one a technical assessment and the other a broad discussion of food safety policies. In the first report,[167] the NAS confirmed an earlier study by the Congressional Office of Technology Assessment [168] that saccharin is carcinogenic in animals and therefore poses a potential risk to humans. However, the report also concluded that saccharin is a relatively weak carcinogen in rats. In its second report, a divided committee recommended that Congress revise food safety provisions by abolishing the special requirements of the Delaney Clause and simplifying food safety policies by relying instead on the general safety provisions of the Act.[169] A minority statement appended to the committee report rejected this view, and in essence recommended retaining the Delaney Clause.

The moratorium on a saccharin ban as a food additive expired on May 23, 1979. In mid-1979, Congress was considering legislation to extend the moratorium until June 30, 1981.[170] FDA planned to await the outcome of the legislation before taking further action. A number of epidemiological studies have provided inconclusive evidence of saccharin's cancer-causing potential in humans, and a large study is now underway at the National Cancer Institute.[171] The original FDA proposal would have banned saccharin as a bulk additive in food, but would have permitted its continued use as a table top sweetener if the industry could demonstrate that it had benefits as an over-the-counter drug for people on weight reduction diets or for diabetics.

No substitute for saccharin has yet been approved by FDA. Cyclamates, which were banned as an artificial sweetner in 1970, are being reviewed. Aspartame has been submitted for approval but not yet accepted and substantial questions of its safety have been raised. Xylitol was cleared for use in 1963, but in 1977 it, too, was shown to be carcinogenic in mice. FDA is currently considering Neo DHC (Neohesperidin dehydrochalcone), a derivative from grapefruit peel, but more data are required before a decision can be reached.[172]

Table 3–8

Federal Regulations for Controlling Human Lead Exposure

Medium Through Which Exposure Occurs	Federal Agency	Specific Exposure Pathway Being Controlled	Federal Regulations	Citation
		Nonfood Substances		
Lead paint in housing	Housing and Urban Development	Exposure of children to lead-based paint on surfaces of residential structures.	Notification to purchasers and tenants of HUD-associated housing constructed prior to 1950 of the hazards of lead-based paint poisoning.	24 CFR 35.5
			Prohibition against the use of lead-based paint in HUD-associated housing.	24 CFR 35.14
			Elimination of lead-based paint hazards in HUD-associated housing.	24 CFR 35.24
			Elimination of lead-based paint hazards in federally owned properties prior to sale for residential habitation.	24 CFR 35.56
			Prohibition against the use of lead-based paint in federal and federally-assisted construction or rehabilitation of residential structures.	24 CFR 35.62

Lead paint in housing	Health, Education, and Welfare	Exposure of children to lead-based paint on surfaces of residential structures.	Grants to develop local programs for detection and treatment of lead-based paint poisoning and for the identification and elimination of the hazards of lead paint in residential structures.	42 CFR 91
Lead in paint, and toys and furniture with painted surfaces	Consumer Product Safety Commission	Exposure of children to lead-based paint on surfaces of residential structures, toys, and furniture.	The following consumer products have been declared as banned hazardous products: • paint and other similar surface coatings containing more than 0.06 percent lead. • toys and other articles intended for use by children that bear paint containing more than 0.06 percent lead. • furniture that bears paint containing more than 0.06 percent lead.	10 CFR 1303.4
		Air		
Ambient air (including dust and dirt)	Environmental Protection Agency	Exposure of the general population and especially young children (1–5 yrs.) to airborne lead from stationary and mobile emission sources.	The national primary and secondary ambient air quality standards for lead are 1.5 $\mu g/m^3$, maximum arithmetic mean averaged over a calendar quarter.	40 CFR 50.12
Ambient air	Environmental Protection Agency	Exposure of the general population and especially young children (1–5 yrs.) to airborne lead from motor vehicles combusting leaded gasoline.	No gasoline refiner shall exceed an average lead content of 0.5 grams of lead per gallon after October 1, 1979, averaged over a 3-month period.	40 CFR 80.20

Table 3–8 (continued)

Medium Through Which Exposure Occurs	Federal Agency	Specific Exposure Pathway Being Controlled	Federal Regulations	Citation
		Occupational Exposures		
Occupational exposures to lead in all industries covered by OSHA except construction and agriculture.	Occupational Safety and Health Administration	Exposure to airborne lead in the workplace.	50 $\mu g/m^3$ averaged over an 8-hour period.	29 CFR 1910.1025
		Water		
Drinking water	Environmental Protection Agency	Exposure of the general population to lead in drinking water supplies by public water systems.	The interim national primary drinking water maximum contaminant level for lead is 50 $\mu g/l$.	40 CFR 141.11
		Food and Eating Utensils		
Apples, apricots, celery, peaches, pears, strawberries, tomatoes, and several other specific fresh fruits and vegetables	Environmental Protection Agency	Exposure of the general population to lead arsenate pesticide residues in or on raw agricultural commodities.	The tolerance for lead arsenate pesticide residues in or on 10 designated raw fruits or vegetables is limited to 7 ppm of combined lead.	40 CFR 130.19

Citrus fruits	Environmental Protection Agency		The tolerance for lead arsenate pesticide residue on citrus fruit is limited to 1 ppm of combined lead.	40 CFR 180.19
Ceramic dinnerware, enamelware, and pewter	Food and Drug Administration	Exposure of the general population to lead that is leachable from pottery glazes.	The action level for leachable lead from pottery glazes is 7 μg/ml.	FDA Administrative Guidelines 7417.03
Silver-plated holloware	Food and Drug Administration	Exposure of the general population to lead that is leachable from silver-plated holloware.	The action level for leachable lead from silver-plated holloware for use by adults is 7 μg/ml.The action level for leachable lead-plated cups intended for use by infants is .5 μg/ml.	FDA Administrative Guidelines 7417.01

Source: Compiled by the U.S. Department of Housing and Urban Development, May 1979.

NITRITES

Until recently, the ingestion of low concentrations of nitrite salts, which have been present in cured meat products for decades both as protection against botulism and to improve the meat's appearance, was not believed to pose a chronic health hazard. However, it has been long known that high levels of nitrite ingestion will cause acute poisoning due to methemoglobinemia (making it impossible for the blood to carry adequate oxygen to the body's tissues).

In the mid-1960s, reports linked the ingestion of nitrites and nitrates to the possible formation of carcinogenic nitrosamines. In model systems, nitrites were found to react with secondary amines to form nitrosamines. Further research has confirmed that low concentrations of nitrosamines are sometimes formed in meat products, such as bacon, when heated to high temperatures. FDA and the USDA have been trying to minimize this danger by lowering the levels of nitrite added in cured meat products and by requiring the addition of sodium ascorbate or sodium erythorbate, each of which competes with secondary and tertiary amines for reaction with nitrite, thus reducing the potential formation of nitrosamines.[173]

In 1971, a study at the Massachusetts Institute of Technology showed that rats fed nitrites developed a statistically significant increased incidence of malignant lymphomas.[174] This result prompted FDA to sponsor a much larger rat study that, in May 1978, confirmed the previous results.[175]

However, when the FDA study was made public, a number of questions arose regarding the interpretation of the results; primarily, several pathologists disagreed over the interpretation of animal tissue slides in the study. Therefore, a full-scale pathology review of the study was commissioned, with preliminary review results expected in September 1979, and final data due in November. After a full statistical analysis, FDA will probably release a final report in early 1980.

The Administration has submitted to Congress the Nitrite Moratorium and Food Safety Act, which would provide a moratorium on action to eliminate the use of nitrite in cured meats until May 1, 1980, if nitrite is confirmed as a carcinogen, and for an orderly phaseout to nitrite-free products. The legislation arose from an opinion of the Justice Department that the Delaney Clause and general provisions of the law do not permit time for a phaseout over an extended period of time. FDA and the Department of Agriculture are currently planning, should it be necessary, for a gradual phaseout. FDA is also examining the broader health implications of human exposure to nitrite from all sources, as well as any possible health risks that might result from the removal of added nitrite to food.

REDEFINING RESIDUES

Prior to 1962, the Delaney Clause did not distinguish between compounds added directly to human food and compounds that might indirectly enter food. In 1962, the law was changed so that com-

pounds entering human food through administration—such as veterinary drugs or additives in animal feed—were not covered by the Delaney Clause if the additive was found to be safe for the food-producing animal and if no residue of the additive was found in any edible portion of the animal after slaughter or in a food product derived from the animal, such as milk or eggs. This change, which requires *the absence of residues,* resulted primarily from the debate over the use of diethylstilbestrol (DES) in animal feed.

However, since 1962 the ability to detect extremely low levels of many substances has improved immensely. Because of this, levels of DES (and many other substances) in edible meat that were once below the limit of measurement, and thus "not present," are now measurable. Table 3–9 shows the dramatic improvements in detection. DDT in the 1940s could only be detected if it were present at levels of about 10 parts per million; now it is possible to reliably detect a few parts per billion, or a residue one ten-thousandth as prevalent. For some other substances even more dramatic advances have been made. In Table 3–10 substances of particular concern from the standpoint of health are listed along with their current limits of detection.

In recognition of the increasingly accurate technology, FDA has proposed an operational definition of the "no residue" requirement not on the basis of "presence" or "absence," but on the basis of acceptable risk.[176] FDA proposes to define "no residue" on the basis of animal studies for carcinogenicity, extrapolating the doses producing tumors by a linear method to the amount associated with a risk of one in a million. FDA deems this risk acceptable, posing no significant risk to the food-producing animals, and judges that the level does not significantly increase human cancer risk.

This definition of "no residue" is expected to permit use of certain animal drugs and feed additives and not others. Different carcinogens show different potencies in various animal species or strains. Under the FDA formula, a potent animal carcinogen might require a residue level that actually was zero or undetectable by highly sophisticated methods of detection because any residue at all would exceed the risk level of one in a million, and FDA would not allow the product to be marketed. On the other hand a weak animal carcinogen might be allowed in detectable, even relatively large, residue amounts because the risk is estimated to be less.

In Table 3–11, five examples are given of the doses in parts per billion for animal carcinogens representing a lifetime risk of one in a million. The extrapolation of risk from high to low doses in animals and using it to estimate risk to humans involves many uncertainties. To avoid underestimating the actual risk to humans, FDA proposed building into the procedure a number of conservative and prudent assumptions. They are:

- The upper bound—the 99 percent confidence limit—is used when analyzing statistically the data in animals to determine the estimated risk;

- The one in a million lifetime risk is expected only if the maximum acceptable residue is consumed every day for a lifetime, which is unlikely;
- If several different animals tests, using different animal species or strains, yield different results, the results with the animals that are most sensitive to cancer induction—the study with the highest level of response—will be used; and
- The derivation of the level of residue rests on the assumption that the only health risk is cancer, so it does not take into account other competing risks that could effectively lower the risk of cancer.

Table 3–9

Trends in Analytical Chemistry Detection Techniques

Compound and Date	Detection Technique	Limit of Measurement*
DDT		
1940s, 1950s	Colorimetric	10 ppm
1950s, 1960s	Paper chromatography	1 ppm
1970s	Gas chromatography	Few ppb
	Gas chromatography/mass spec	
Dioxins		
1940s	—	—
1950s, 1960s	Thin layer chromatography	Nonquantitative
1970s	Gas chromatography, mass spec	Less than 0.1 ppb
Nitrosamines		
1940s	—	—
1950s, 1960s	Thin layer chromatography	10–20 ppb
1970s	Gas chromatography/mass spec	2 ppb
Lead		
1940s	Colorimetry	About 10 ppm
1940s, 1950s	Polarography	About 0.1 ppm
1960s	Atomic absorption	About 1 ppm
1970s	Atomic absorption	About 1 ppm
Cadmium		
1940s	—	—
1950s, 1960s	Colorimetry	About 50 ppb
1960s, 1970s	Atomic absorption	About 0.3 ppb
Carbamates		
1940s	—	—
1950s, 1960s	Thin layer chromatography, gas chromatography	50–100 ng
1970s	Gas chromatography	About 1 ng
Organophosphates		
1940s	—	—
1950s	—	—
1960s	Gas chromatography	About 40 pg
1970s	Gas chromatography	About 40 pg

* ppm=parts per million
ppb=parts per billion
ng=nanograms
pg=picograms

Source: Adapted from the Food and Drug Administration, 44 Federal Register 17076 (1979).

Table 3–10

Some Assays for Trace Contaminants in Food That Reflect Current Capabilities

Substance Under Assay	Food	Limit of Measurement (ppb) [a]	Detection and Confirmatory Techniques
Cadmium, copper, and lead	Several types	5	Anodic stripping, voltammetry
N-Nitrosamines	Several types including meat	10	Gas-liquid chromatography (GLC); mass spectrometry (MS)
Aflatoxins B1, B2, G1, G2	Peanut butter	[b]5.0	High pressure liquid chromatography, fluorescence detector
Benzo(a)pyrene	Smoked foods	2	Thin layer chromatography (TLC) ultraviolet and fluorescence detector
Aflatoxin M1	Milk	0.1	TLC-fluorescence detection chemical derivation
Aflatoxins B1, B2, G1, G2	Peanut butter Corn	5.0 —	TLC-fluorescence detection TLC chemical derivation
Aflatoxin B1	Eggs	0.1	TLC flourescence detection, chemical derivation
Arsenic, selenium, antimony, and tellurium	Several foods	10 to 20	Atomic absorption; spectrometry, chemical derivation
Several chlorinated pesticides	Several foods	30 to 50	GLC—2 different
Tetrachlorodibenzo-dioxin	Fat, milk, others	.0001 to .010	Chromatography high resolution MS (direct probe)

[a] Parts per billion.
[b] Sum of all four compounds.

Source: Adapted from the Food and Drug Administration, 44 Federal Register 17076 and 17077 (1979).

Table 3–11

Estimated Acceptable Total Dietary Level of Several Known or Suspected Carcinogens for a Lifetime Risk Level of 1 in 1 Million

Compound	Dose (ppb) [a]
DDT	.4
Dimethylnitrosamine	.05
Ethylene thiourea	2.0
NTA	260.0
Vinyl chloride	6.7

[a] Parts per billion.

Source: Adapted from the Food and Drug Administration, 44 Federal Register 17077 (1979).

Hearings on the FDA proposal were held in June 1979, and the proposal, if adopted, could go into effect as early as 1980.

In June 1979, FDA banned diethylstilbestrol (DES) as a drug or feed additive in cattle and sheep.[177] DES, used since the 1950s to promote animal growth, is carcinogenic in people and animals. It is also used to treat certain cancers and other medical conditions in people, but these uses were not affected by the ban. DES was previously banned in animal feed in 1972 and as a drug implanted in animals in 1973, but a U.S. District Court overturned the bans in 1974, because hearings had not been held. The FDA's recent decision to ban DES followed lengthy hearings, initiated in 1976. It upheld an initial decision in September 1978 by the administrative law judge who presided at the hearings.

HAZARDOUS SUBSTANCES EXPORT POLICY

The export of hazardous substances from the United States aroused strong concern and action by Congress in the past year. A subcommittee of the House Committee on Government Operations examined a number of incidents in which goods were legally exported to other countries after the United States had banned them or greatly restricted their use at home to protect human health or the environment.[178] Some examples are the following:

- Children's pajamas treated with Tris, the flame retardant found to be a carcinogen, were exported for more than a year after sales were banned in the United States;
- Pesticides such as aldrin, endrin, chlordane, heptachlor, and strobane were still exported freely after they were suspended or cancelled for most domestic uses; and
- The powerful and hazardous pesticide Leptophos was manufactured (quite legally) for export only, with no requirements for U.S. approval or notice to importing countries that the product was not approved for use in the United States. Tragic results followed. Illness in a number of farmers as well as death of more than 1,000 animals in Egypt were attributed to the use of Leptophos there between 1971 and 1976. Workers in the Leptophos manufacturing plant in Bayport, Tex., became seriously ill after exposure to the chemicals in the pesticide, and manufacture was eventually stopped. Meanwhile, Leptophos had been exported to more than 30 countries.[179]

The reaction of Congress was to amend the law. Strengthened requirements for export notification were added to the amended FIFRA and to the several consumer product safety laws administered by the Consumer Product Safety Commission. Other provisions relating to export of products regulated in the United States were already present in TSCA and in some of the laws administered by the Food and Drug Administration.

These provisions for notification and disclosure reflect the belief that the United States has a responsibility to aid in the protection of health and safety abroad, and to try to avoid damage to the world environment. Because countries differ greatly in economic, social, and cultural conditions and in their needs for pesticides and other products that may be hazardous, it is generally appropriate for the other countries to make their own judgments about hazardous substances. The United States *can* try to assure that the decisions will be informed ones, first, by providing to importing countries the information we have on hazardous substances, in convenient form; and second, by working through international organizations on cooperative research, data exchange, and coordination of control procedures.

The existing laws relating to hazardous exports, and the rules of the various agencies concerned, are at least a partial answer to the need for an effective U.S. policy. In response to a request from Congress, an interagency working group was established in the late summer of 1978 under the leadership of Esther Peterson, Special Assistant to the President for Consumer Affairs, to take a comprehensive look at the subject. The working group was asked to assess the current state of the law on export of hazardous products, to determine whether new policies were needed to deal with the issues more consistently, and to develop the new policies as needed.[180] The working group is expected to complete its recommendations in the fall of 1979.

Among the issues the working group is considering are the following:

- Improved publication of general information on U.S. regulatory actions and hazard assessments;
- Notification by the United States to the governments of importing countries that hazardous products are being shipped to particular countries;
- Labeling of hazardous products;
- International cooperative activities; and
- Restrictions or outright bans on exports under certain exceptional circumstances.

A summary of the major U.S. provisions affecting the export of hazardous substances, and a brief look at current international activities follows.

EPA: TOXIC SUBSTANCES CONTROL ACT

TSCA requires an exporter of a regulated substance to notify EPA, and EPA shall give notice of the regulatory action to the government of the importing country. The statutory requirement is very general, not specifying the content of the notice, procedures, or timing of notification. EPA was expected to propose regulations for implementing this provision in the fall of 1979.

TSCA also authorizes EPA to order testing or otherwise to regulate substances intended for export, in cases when export of the substance is found to present "an unreasonable risk of injury to health within the United States or to the environment of the United States"—in other words, when the substance may somehow re-enter the U.S. environment, coming back to haunt us. The environmental impact statement that must accompany Section 6 regulatory action will cover potential unreasonable risks to human health or the environment in the global commons as well as in the United States.

Other than the provisions mentioned above, TSCA authority does not apply to substances, mixtures, or articles manufactured for export and labeled as such.

EPA: FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT

Until the 1978 amendments the federal pesticide law permitted the export of pesticides whether or not they had been approved for use within the United States, so long as they were intended solely for export and were prepared for and packed according to specifications of the foreign purchaser. The Act did provide that EPA must notify the State Department whenever a pesticide registered for U.S. use is suspended or cancelled, and that the State Department notify foreign governments and appropriate international agencies of such action. EPA was also directed to cooperate with the State Department and other federal agencies in international efforts to improve pesticide research and control.

In September 1978, amendments to the pesticides law strengthened the export safeguards and notification procedures.[181] Although pesticides that are destined for export are exempt from registration under FIFRA, they are now subject to much the same labeling requirements as are domestic products. In addition, pesticides that are not registered for U.S. use can be exported only if prominently labeled as follows: "Not registered for use in the United States of America." Such pesticides can be exported only if the foreign purchaser has signed, before the export, a statement acknowledging that he or she understands that the pesticide is not registered and cannot be sold in the United States. The U.S. exporter must send a copy of the acknowledgement statement to EPA, for transmittal to appropriate officials of the foreign government.

The export of pesticides is one of the more troublesome aspects of hazardous substances export policy for two reasons. First, most pesticides, by their very nature and purpose, are toxic and can easily cause serious health and environmental hazards, especially if used improperly (e.g., in the wrong amounts, on the wrong pests, at the wrong time). Even under proper use conditions some pesticides pose such serious risks that they are banned or severely limited in the United States. However, the risks and benefits of their use may be considered quite differently in another country.

Second, there is a great demand for U.S. pesticides, particularly in developing countries, which do not always have the trained personnel to evaluate the safety of the pesticides or to insure their proper use. An estimated 15 percent of the 588 million pounds of pesticides under EPA jurisdiction that were exported in 1975 were not approved for use in the United States, because they had been cancelled, suspended, or were never registered.[182]

CPSC: CONSUMER PRODUCT SAFETY ACT, FEDERAL HAZARDOUS SUBSTANCES ACT, AND FLAMMABLE FABRICS ACT

In October 1978, Congress amended these acts [183] to require that 30 days before the export of any product that does not comply with an existing or proposed domestic standard or regulation under these laws administered by the Consumer Product Safety Commission (CPSC), the exporter must notify the Commission. CPSC notifies the foreign government of the intended export and of the existing or proposed standard. CPSC also files the notification statement in the *Federal Register*. According to proposed CPSC procedures,[184] such notification may be made prior to the first shipment in any year to a given country without further notification for subsequent shipments to that country in that year.

FDA: FOOD, DRUG, AND COSMETIC ACT AND PUBLIC HEALTH SERVICE ACT

New drugs that have not yet received approval for United States use may not be exported for commercial use under any circumstances. There are provisions allowing the export of drugs for investigational use only, following formal procedures involving the State Department and the foreign government. Drugs that are approved for U.S. use may be exported without special requirements, even if misbranded or adulterated, provided they are labeled for export only and meet the requirements of the foreign government.

Both cosmetics and foods may be exported with no permit required, if they are labeled for export and not offered for domestic sale, and if they are in compliance with the laws and requirements of the foreign purchasing country.

Somewhat different requirements apply to other products under FDA jurisdiction. For biological products no export is allowed for products that cannot be sold in the United States; for electronic products, export is allowed under certain liberal conditions; and for medical devices, exports are allowed under more limited conditions.

INTERNATIONAL ACTIVITIES

While adopting stricter policies for its own exports of hazardous substances—especially in requirements to notify importing coun-

tries—the United States is also urging increased international attention to this matter. Several international efforts for improved hazard-alert systems and common standards were already planned or underway. Under consideration for improvement are:

- The notification and consultation procedure of the Organization for Economic Cooperation and Development, which alerts member countries to pending regulatory actions on pesticides and other toxic substances that may have an international impact;
- Activities by the World Health Organization (WHO) and Food and Agricultural Organization (FAO) of the United Nations to establish environmental health criteria for various toxic substances, food standards, and residue limits for pesticides;
- Planned activities of the International Registry of Potentially Toxic Chemicals of the United Nations Environment Program, designed to be a data clearinghouse for information on potentially toxic substances;[185] and
- Various bilateral and multinational agreements and information exchange activities.

In addition to supporting these efforts, the United States is urging OECD to devote a portion of its chemicals program to considering international agreement on export of hazardous substances from producer countries. Common export notification procedures and more uniform labeling requirements for toxic substances and hazardous products in international commerce would be examined.

The OECD, which is composed of the major noncommunist industrialized nations of the world, is an appropriate forum to begin considering common notification and labeling procedures, but consultations will have to include other nations as well, particularly developing nations. In 1977, and again in 1978, the UNEP Governing Council supported strong protective measures to prevent the export of hazardous substances that are restricted or not registered for use in the exporting country, unless the government of the importing country clearly understands the hazards and agrees to the importation.[186]

The greater the international agreement that can be reached, the less will be the cost and burden to the United States of our efforts to assure health and safety protection abroad; the less likely will be a large foreign supply of hazardous products; and the less likely will be any adverse impacts on U.S. trade of our export policies.

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CHAPTER 4

MUNICIPAL SOLID WASTE

Before 1970 the question of what to do with a city's waste was hardly ever asked. The answer was obvious: either burn it in an incinerator or take it to a dump.

During this decade conditions have changed. Obtaining land for dumping has become more difficult as existing sites have filled up, nearby residents have opposed new sites, and the commercial or ecological importance of places once considered convenient dump sites—such as wetlands—has been recognized. At the same time, the total amount of waste has been increasing. Municipal waste, which rose at a rate of 5 percent a year from 1960 to 1970, slowed to a rate of about 2 percent a year from 1970 to 1978, but is still on the upswing. In fact, as Figure 4–1 shows, residential and commercial gross discards rose in every year of this decade except 1974 and 1975, both recession years. Total U.S. municipal waste was estimated at 154 million tons for 1978, the equivalent of 1,400 pounds per person.

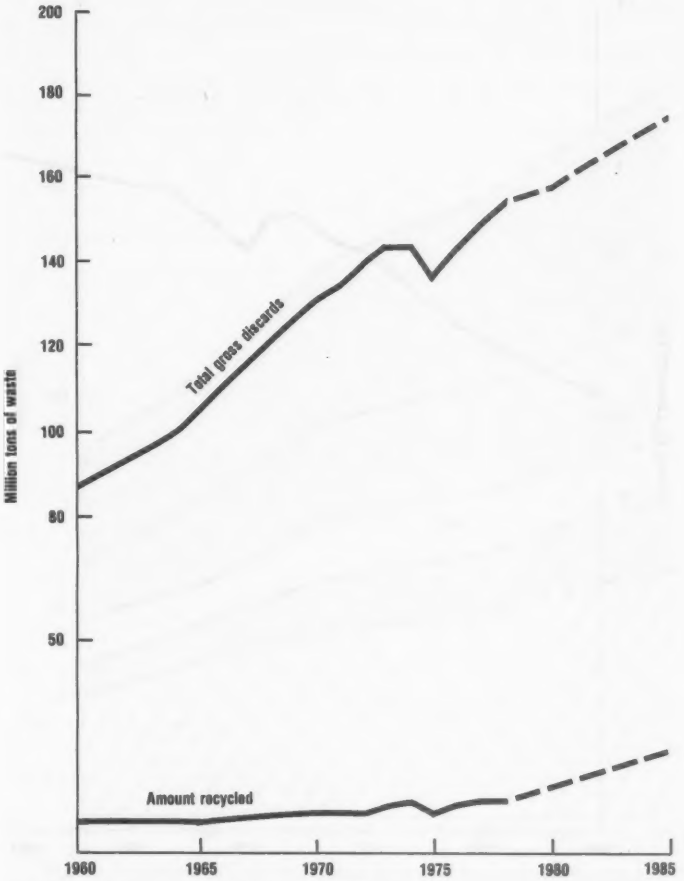
The amount of municipal waste generated per person also increased overall for the decade, declining somewhat during 1974 and 1975, but then rising again to an average level of 3.85 pounds per day in 1978 (see Figure 4–2). The rate of increase per person for the period 1970 to 1978 averaged approximately 1 percent annually. During this period, labor and equipment costs associated with waste disposal also rose.[1]

As the economics and politics of waste disposal have changed, so has environmental awareness. Solid waste disposal is now coming under much more stringent regulation than in the past. The Resource Conservation and Recovery Act,[2] passed by Congress in 1976, set as an objective the complete elimination of open dumps and the upgrading of other waste disposal practices. It offered federal help to states to create waste management plans and to bring waste disposal systems up to federal standards. These changes could easily double the cost of landfilling wastes in many areas.

Squeezed by increasing amounts of waste, disappearing disposal sites, and tightening restrictions on use of the sites, many local government officials and businesses involved in solid waste disposal have begun to consider alternatives to disposing of wastes in sanitary landfills. Municipal trash, after all, contains many potentially useful items.

Figure 4–1

Estimated U.S. Post-Consumer Solid Waste Generated and Recycled, 1960–85[a]



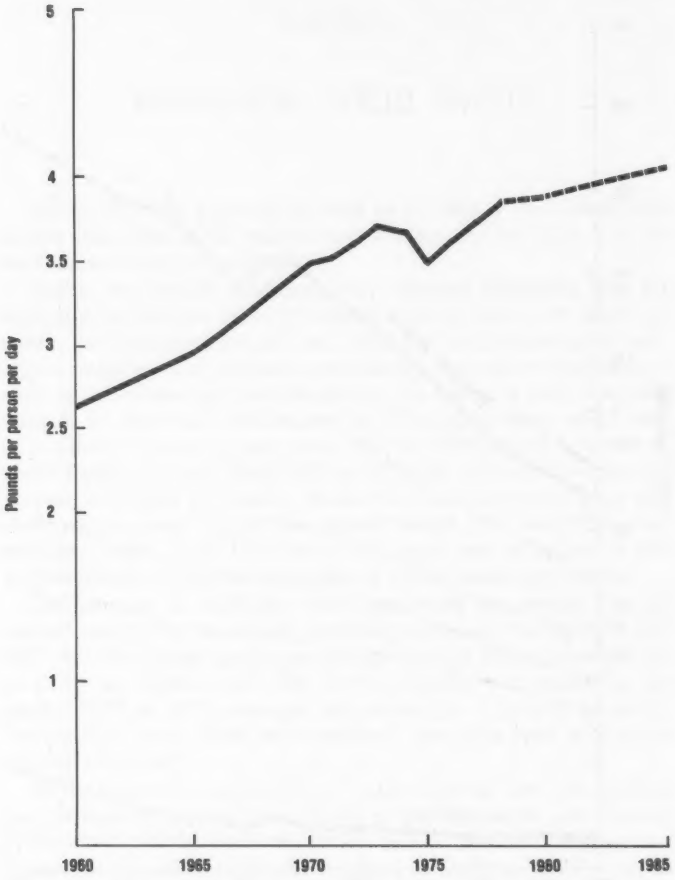
[a]Projections assume no major new federal policies to reduce waste generation.

Source: Analysis by Franklin Associates, Ltd. for U.S. Environmental Protection Agency, Office of Solid Waste.

Newspapers, aluminum and steel cans, glass bottles, and rubber tires can all be reused, either as is or after reprocessing. Food wastes have potential value as compost. A wide variety of components, including paper, food, and yard wastes, can be burned to make energy—a fact of great importance in a world of rapidly rising energy prices. (The

Figure 4–2

Estimated Average Individual Waste Generation, 1960–85 [a]



[a]Projections assume no major new federal policies to reduce waste generation.

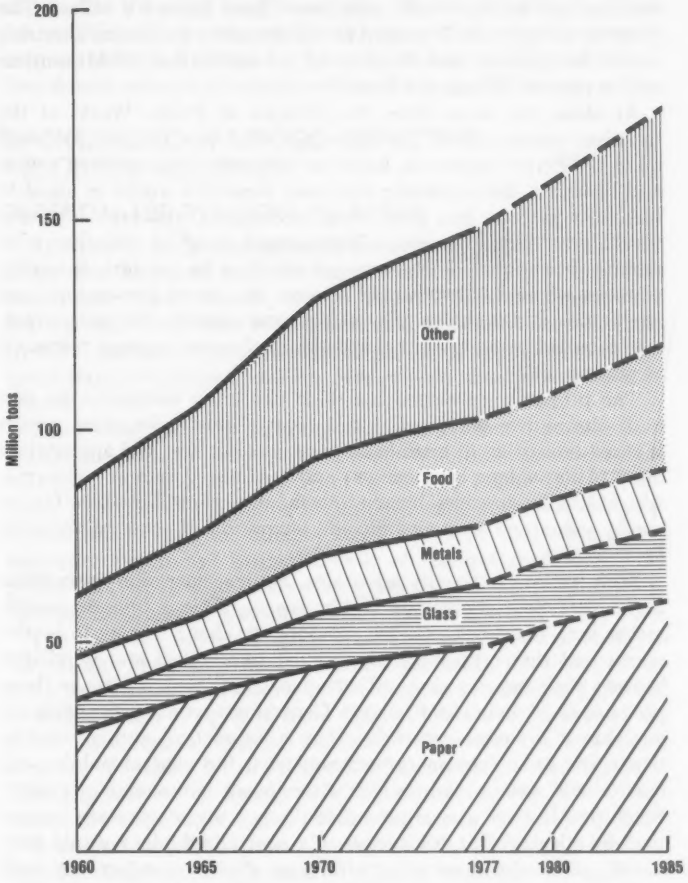
Source: Analysis by Franklin Associates, Ltd. for U.S. Environmental Protection Agency, Office of Solid Waste.

estimated composition of the nation's municipal waste for the period 1960 to 1985 appears in Figure 4–3.)

Two of the cities that showed an early interest in recycling were St. Louis, Mo., and Denver, Colo. In St. Louis, the U.S. Environmental Protection Agency (EPA) and the Union Electric Co., a private utility, began operating a small pilot plant for recovering

Figure 4–3

Estimated[a] Generation of Residential and Commercial Post-Consumer Solid Waste, by Material, 1960–85



[a]Projections assume no major new federal policies to reduce waste generation.

Source: Analysis by Franklin Associates, Ltd. for U.S. Environmental Protection Agency, Office of Solid Waste.

recyclable materials and energy from municipal wastes in 1972.[3] By 1976, the success of the pilot project had convinced Union Electric and city officials that it was time to mount a major resource recovery effort. Union Electric proposed building a trash-to-energy plant that would be more than 50 times larger than the test facility, with the capacity to handle all the solid waste from the city of St. Louis as well as some from surrounding counties—8,000 tons per day.[4]

Shredding machines would tear the tons of garbage into inch-long pieces. Magnets would extract the iron. Blowers would separate out the lighter, burnable portion (paper, food wastes) from the heavier glass and other nonburnable materials. The burnable fraction would then be fed, together with coal, into Union Electric's boilers. The plant would generate 5 percent of the electricity for Union Electric's service area, which includes most of the eastern half of Missouri as well as parts of Illinois and Iowa.[5]

At about the same time, the Director of Public Works of the suburban community of Northglenn, Colo., near Denver, proposed quite a different approach, based on household separation of wastes and biological decomposition processes. Residents would be asked to sort their garbage into glass, cans, newspapers, and organic wastes (food, grass clippings, etc.). The organic material, together with manure from farms in the area, would then be fed into anaerobic digesters where bacteria would convert the wastes into natural gas (methane) and a sludge. The sludge, and possibly the newspapers, would be fed to earthworms, and the earthworm castings marketed as potting soil.[6]

The proposals developed for these two cities exemplify the two basic alternatives for recycling solid waste: source separation, which is based on sorting of trash in the home or business and appropriate reuse of its various components; and centralized resource recovery, which usually involves burning trash at a central facility for its energy value and may also include separation of some components for recycling.

Each approach has its advocates. Source-separation enthusiasts argue that their method is highly energy-efficient because people rather than machines separate components; that it is easy to implement; and that centralized systems are impractical and unreliable because their massive size and technological complexity make them prone to breakdowns and failures. Centralized-system proponents argue that it is source separation that is impractical and unreliable, depending as it does on cooperation from the general public, and that central systems can provide a significant new source of energy. Some people have also argued that the two approaches are incompatible, alleging that institution of a centralized plant would preclude neighborhood recycling efforts or efforts to reduce the total amount of garbage generated. The economics of the central facility, it is claimed, depends on having large amounts of garbage to process.

Happily, evidence is accumulating that the two approaches are not incompatible except, perhaps, in their extreme applications. A 100-percent-effective bottle, can, paper, and compost recycling program might be incompatible with an extremely high-technology facility designed to separate glass, steel, and aluminum trash and make methane or artificial oil from the residue, because the central plant would lack the necessary raw materials. However, as a practical matter, neither a 100-percent-effective recycling program nor a high technology trash-to-gas resource recovery plant has yet been

shown to be a realistic option. No example of either one exists anywhere in the country today, despite numerous attempts. As we shall see, neither the St. Louis nor the Northglenn projects cited above actually proceeded as planned, in part because they were too ambitious. On the other hand, reasonably effective recycling programs are possible and are compatible with most of the simpler resource recovery systems. Indeed, for a variety of reasons discussed below, they should enhance or complement each other's effectiveness.

BACKGROUND: FACTORS AFFECTING RESOURCE RECOVERY

POTENTIAL FOR RESOURCE RECOVERY

Recovery of energy and materials from municipal solid waste is not a new idea. European countries began recovering energy from urban wastes after World War II, when it became apparent in many cities that garbage would have to be incinerated to conserve landfill space. By 1977, Denmark was converting 60 percent of its wastes to energy, Switzerland 40 percent, and the Netherlands and Sweden each 30 percent.[7]

The United States, by contrast, converted less than 1 percent of its municipal wastes to energy in 1977. Even optimistic projections show that figure rising to just 10 percent by the late 1980s.[8] In 1977, another 7 percent of the nation's municipal solid waste was being recovered for its material value by recycling centers and other source separation programs.[9] Estimated rates of resource recovery for the period 1960 to 1977 are shown in Table 4–1, together with projections for 1985, assuming a continuation of present trends.

The potential for "mining the trash" for materials and energy is very large. The composition of municipal trash, on a percentage basis, is indicated in Table 4–2. The amount of paper and glass in municipal waste is equal to more than two-thirds of the annual national consumption of these materials.[10] Likewise, the amount of aluminum in wastes is more than one-fifth of national consumption.[11] The Department of Energy (DOE) estimates that 200 million tons of municipal solid waste, the amount now projected for 1990,[12] plus another 14 million tons of sewage solids, represent a total recoverable Btu content of 2 quads.[13] (A quad is one quadrillion British thermal units, or Btus; total U.S. energy use in 1978 was approximately 78 quads.) Recovery of metals and glass in waste would save an additional quad because it takes less energy to recycle these materials than to process them from virgin ores. According to DOE, waste-to-energy technologies that are already available could recover about two-thirds of the potentially recoverable energy resources in wastes.[14]

ECONOMICS OF WASTE DISPOSAL

Until very recently, the cost of land disposal was low enough and land for this purpose plentiful enough that local governments had

Table 4–1

Estimates and Projections of Recovery of Residential and Commercial Post-Consumer Solid Waste, Selected Materials, 1969–85

(in thousands of tons, as-generated wet weight)

Material	1960	1970	1977	1985
Ferrous metals				
Source separation	—	—	35	50
Magnetic separation [a]	50	150	200	200
Mixed-waste processing	—	—	50	400
Total	50	150	285	650
Aluminum				
Source separation	—	10	140	225
Mixed-waste processing	—	—	—	5
Total	—	10	140	230
Paper				
Source separation	5,575	7,115	10,180	12,150
Glass				
Source separation	100	160	500	865
Mixed-waste processing	—	—	—	5
Total	100	160	500	870
Rubber				
Source separation	330	255	160	170
Total Materials Recovery				
Source separation	6,005	7,540	11,015	13,460
Magnetic separation [a]	50	150	200	200
Mixed-waste processing	—	—	50	410
Total	6,055	7,690	11,265	14,070
Energy recovery from combustibles	—	—	750	9,400
Total recovery	6,055	7,690	12,015	23,470
Total gross discards	87,000	131,000	148,000	175,000
Percent recovered	7	6	8	13
Percent source separated	7	6	7	8

[a] Includes systems magnetically separating ferrous scrap, but doing no other resource recovery.

Source: Franklin Associates, Ltd., "Post-Consumer Solid Waste and Resource Recovery Baseline," prepared for the Resource Conservation Committee (Washington, D.C., April 6, 1979), p. 21.

little incentive to recover energy or useful products from solid waste. In 1978, municipal solid waste in the United States was being sent for disposal to 18,500 sites covering a total of 500,000 acres.[15]

In recent years, however, public opposition to new disposal sites has become a major hindrance to sanitary landfill. A 1978 study of 23 cities reported "moderate" or "severe" public opposition to new disposal sites in two-thirds of the localities contacted.[16]

Public concern, coupled with rising labor, equipment, energy, and environmental control costs, has caused cost increases for waste disposal in many areas to become acute. By 1978, the average cost of solid waste collection and disposal was estimated at more than $25 per capita, or about $43 per ton.[17] The cost of land disposal alone

Table 4–2

Estimated Composition of Residential and Commercial Post-Consumer Solid Waste, 1977

(as-generated wet weight in millions of tons and percents)

Materials	Millions of Tons	Percent of Total
Paper	49.5	33.5
Glass	14.7	9.9
Metals	13.6	9.2
Ferrous	(11.8)	(8.0)
Aluminum	(1.4)	(0.9)
Other nonferrous	(0.4)	(0.3)
Plastics	5.3	3.6
Rubber & leather	3.9	2.6
Textiles	3.0	2.0
Wood	4.7	3.2
Total nonfood products	94.7	64.0
Total nonfood products	94.7	64.0
Food waste	25.2	17.0
Yard waste	25.9	17.5
Miscellaneous inorganics	2.2	1.5
Total generation	148.0	100.0

Source: Franklin Associates, Ltd., "Post-Consumer Solid Waste and Resource Recovery Baseline," prepared for the Resource Conservation Committee (Washington, D.C., April 6, 1979), p. 11.

(excluding collection costs), according to a 1974 survey, the most recent data available, averaged $4.62 per ton nationally, ranging from less than $1 per ton to $19.60 per ton.[18] It is estimated that inflation had raised these costs to $5.39 per ton, on the average, by 1978.[19]

IMPACT OF NEW ENVIRONMENTAL CONTROL REGULATIONS

One of the most important factors now affecting local government decisions on solid waste is new environmental control regulations. The Council of Environmental Quality (CEQ) estimates that compliance with existing and proposed environmental standards for municipal solid waste disposal will increase annual disposal costs by about $700 million annually, or about $4.50 per ton on a national average. The average cost of disposing of a ton of waste at a sanitary landfill will thus almost double. A majority of the increase can be attributed to proposed federal criteria for sanitary landfills although a substantial portion is still due to existing state standards with which localities have yet to comply.

These cost increases will occur gradually between now and the mid-1980s, as the planning and enforcement mechanisms set in motion by the 1976 Resource Conservation and Recovery Act go into effect. The Act requires states to set up solid waste management plans in order to receive certain kinds of federal aid. It also prohibits open dumping except under a timetable or compliance schedule established under an approved state plan. EPA was assigned the task of develop-

ing guidelines in both these areas. The agency issued guidelines for evaluating the acceptability of state plans in July 1979.[20] EPA has also been working on precise criteria for states to use in determining which disposal facilities are acceptable and which should be classified as open dumps. After much debate, classification criteria were proposed in February 1978.[21] They were scheduled to become final in September 1979.[22]

The criteria to be used in identifying "open dumps," known as the "Criteria for Classification of Solid Waste Disposal Facilities," will be far-reaching in their effect. They were proposed under both the Resource Conservation and Recovery Act (RCRA) [23] and the Clean Water Act of 1977 [24] because of similar objectives outlined in both laws.[25] They define acceptable and unacceptable disposal facilities in terms of effects on surface and ground water, air quality, and public safety, as well as in terms of use of a cover material. Facilities that allow open burning or facilities sited in wetlands, floodplains, habitats of endangered species, or recharge zones for principal sources of local drinking water are generally defined as unacceptable under these regulations and will have to be phased out.[26]

In addition, the RCRA also required EPA to develop guidelines for environmentally sound management of solid wastes for states to use as standards. A portion of these guidelines, those pertaining to landfill disposal practices and procedures, were proposed in March

Under the Resource Conservation and Recovery Act, open dumps will have to be phased out. Photographer: Milton Baron.

1979.[27] Final issuance is planned for January 1980.[28] They specify practices to be used to prevent ground water pollution, for example, and to prevent explosions and fires from gas generated by natural decomposition processes.[29]

As of March 1979, all states had taken the first step toward participation in the federal program, namely that of designating a particular state agency to develop a state solid waste disposal plan.[30] The states are now expected to identify, in phases, environmentally unacceptable dumps and to upgrade or phase them out within 5 years from the date of identification.

Many localities are aware of the content of these guidelines and are coming to grips with the fact that as a result they will probably be paying more for landfilling and, in some cases, may simply have no environmentally acceptable landfill site. In the latter case, resource recovery may be a necessity because incineration, the only other alternative, is generally more expensive. However, even if an environmentally sound landfill site is available, resource recovery may prove preferable from an economic point of view. There are two basic approaches to resource recovery: source separation for recovery of materials and centralized waste processing for recovery of energy.

SOURCE SEPARATION

EXISTING PROGRAMS

Source separation programs take a number of forms. Cities collect newspapers, for example, and occasionally glass and cans. Private dealers collect high-quality office paper waste and computer cards. Companies sponsor programs for aluminum can collection, and community groups man drop-off centers for paper, glass, and cans. In 1978, 40 cities had some kind of separate collection program for the full gamut of recyclables, and another 196 collected newspapers. More than 3,000 independent voluntary community recycling centers were in operation, concentrated in California and the Northeast.[31] EPA has estimated that more than 500 offices have paper recycling programs.[32]

EPA gave source separation programs direct encouragement in 1976 when it issued guidelines requiring all federal offices with 100 or more employees to set aside waste paper for recycling.[33] The same guidelines required federal facilities housing 500 or more families, such as military bases, to recycle newspapers. In March 1979, 175,000 federal employees working in 135 facilities were participating in the program and another 100,000 workers were expected to be covered by the end of the year.[34] About 15 state governments were carrying out office source separation programs for waste paper recovery as of May 1978.[35]

At present, paper products—office paper, newsprint, cardboard, etc.—are the materials that are recycled most. Paper accounts for

Many government and private offices separate paper from other wastes for recycling. Photographer: Daniel Brody.

90 percent, by weight, of the materials recovered through source separation.[36] Approximately 20 percent, by weight, of all discarded paper products are recycled.[37]

Recently, the aluminum industry has stepped up its efforts to recover more aluminum because recycling requires only about one-twentieth of the energy needed to produce aluminum from virgin sources.[38] One out of four aluminum cans is now recycled, and it is estimated that 10 percent of all post-consumer aluminum waste is recovered.[39]

The opposite trend is evident in the glass industry. As recently as 1950, 99 percent of all soft drink and 70 percent of beer containers were returnable bottles.[40] Soft drink bottles averaged 40 trips before being discarded. Today, only 25 percent of soft drink and beer bottles are returnable.[41] Altogether, only 3 percent of the glass in municipal trash is recovered through source separation programs.[42] The rate of recovery for iron is even worse: only 2 percent of all iron-bearing municipal waste is reclaimed through source separation or any other recovery technology.[43]

EPA has estimated that a maximum feasible source separation effort nationwide could result in the recycling of about 25 percent, by weight, of total gross discards.[44] Based on projected gross discards of 175 million tons by 1985, a national source separation effort could yield 40 to 45 million tons of paper, metal, glass, and rubber for recycling. However, as discussed below, some towns have been able to cut their wastes by as much as 50 percent, by weight, through recycling.[45]

ADVANTAGES

The main advantage of source separation is that it yields high-quality waste products that can command a relatively high price in

the secondary materials market. It is the only proven method for recovering recyclable newspaper, office paper, corrugated cardboard, color-sorted glass, plastics, and rubber from municipal solid waste, and it is still the best method of recovering aluminum.[46]

Another advantage of source separation is the relative ease with which a program can be started, especially compared with centralized waste processing. Source separation requires minimal capital investment, in many cases less than $50,000 (see Table 4–3). The basic costs are for a warehouse to collect sorted wastes, and, in some cases, for purchase or modification of collection vehicles, as opposed to construction of a large factory complex involving complicated shredding machinery, conveyors, and boilers. Source separation systems may be as large or small as desired. Another advantage is that they consume little energy, other than human, in operation. They may thus be the only practical choice for communities that want a resource recovery system but are too small or remote to build or adequately supply a centralized processing plant.

Table 4–3

Capital Costs for Seven Municipal Source Separation Programs

Municipality	Population Served	Year Built	Capital Cost, Source Separation Facilities (in dollars)
Somerville, Mass.	90,000	1975	$41,000
Marblehead, Mass.	23,000	1975	40,000
Nottingham, N.H.	1,200	1973–75	42,600 *
University of New Hampshire Regional Center	49,100	1974	104,000
Swanzey, N.H.	4,900	1975	39,700
Plymouth, N.H.	3,200	1976	201,000 *
Meredith, N.H.	3,800	1976	100,200 *

* Includes some costs related to site preparation and construction of enclosure for incinerator.

Source: U.S. Environmental Protection Agency, 4th Annual Report to Congress, *Resource Recovery and Waste Reduction* (Washington, D.C., August 1, 1977), p. 34; and Tichenor and Jansen, *Recycling as an Approach to Solid Waste Management in New Hampshire* (Durham, N.H.: University of New Hampshire, June 1978).

These very attractive features of source separation programs have led not just municipalities, but also many public-spirited citizen groups, to establish recycling centers across the country. Unfortunately, many such projects have failed, for the simple reason that the costs of running the program, however low, are still more than can be consistently covered by revenues in the rapidly fluctuating secondary materials market. Source separation still cannot be counted on to be a moneymaker. Such programs are attractive to municipalities at this time because they provide a less costly way of getting rid of some waste than trucking it to, and burying it in, a landfill site. Even so, to make a source separation program work, municipalities must

solve two potential problems: insuring adequate public participation and finding secure markets.

PUBLIC PARTICIPATION RATES

A key obstacle to instituting a municipal source separation program is uncertainty as to its effectiveness. Source separation programs depend heavily on public cooperation for success. Under the right circumstances, public participation rates can be very high. For example, in the small town of Nottingham, N.H., (population 1,200) a source separation program was instituted in 1974 by town ordinance after environmental regulations required closing of the town dump. A study made 3 years later showed that townspeople were recycling 97 percent of the glass, 93 percent of the cans and other metal, and 85 percent of the newspaper (by weight) in their garbage.[47] This meant that the total amount of waste that the town had to incinerate and landfill was cut in half.[48]

The success of this program has been attributed in part both to the manner of its beginning and to the continuing information and education efforts during its operation. The plan was not "imposed from above" by town officials, but rather was adopted, after much public discussion, by a community vote. Compartmentalized waste containers were offered free to anyone wanting them, and more than half the households did. The town sent at least one mailing per year explaining to residents how the system worked and describing its accomplishments.[49]

Source separation programs have been less successful when they are a voluntary adjunct to the main refuse disposal system, rather than an integrated part of it, required by ordinance. EPA reports that voluntary recycling centers on the average reduce the total amount of waste going to disposal in the community by only 1 percent,[50] although some do much better. For example, almost 15 percent of the wastes in Berkeley, Calif., are taken to voluntary community recycling centers.[51]

Socioeconomic factors may also play a role in levels of participation, although very little data exist on this subject, and what evidence there is is far from conclusive. Beginning in 1976, EPA sponsored experimental source separation programs in two Massachusetts communities: Marblehead, a relatively affluent suburb, and Somerville, a blue-collar, densely populated urban community. The towns were motivated to try the programs for similar reasons: high disposal costs—$18.95 per ton and $14.75 per ton, respectively—paid to landfill operators to get rid of their wastes.[52] If the total volume of waste could be reduced and a portion of it sold for reuse, the savings would be considerable.

Both towns passed local ordinances requiring source separation, and both obtained favorable contracts for the sale of recovered materials. Marblehead residents were asked to separate wastes into four categories, Somerville into three, and recyclable wastes were

THE RECYCLING CENTER
WILL BE CLOSED NOV.30th
THANK YOU FOR YOUR INTEREST IN RECYCLING.IF YOU ARE A MADISON RESIDENT, THE CITY OF MADISON WILL NOW ACCEPT YOUR RECYCLABLE MATERIALS ON YOUR REGULAR TRASH PICK-UP DAY.
PLEASE DO NOT LEAVE YOUR METAL AND GLASS CONTAINERS HERE AFTER NOV.30th AS WE WILL NO LONGER HAVE THE EQUIPMENT TO PROCESS THEM.
THANK YOU FOR YOUR COOPERATION
-COLA BOTTLING CO.
OF MADISON

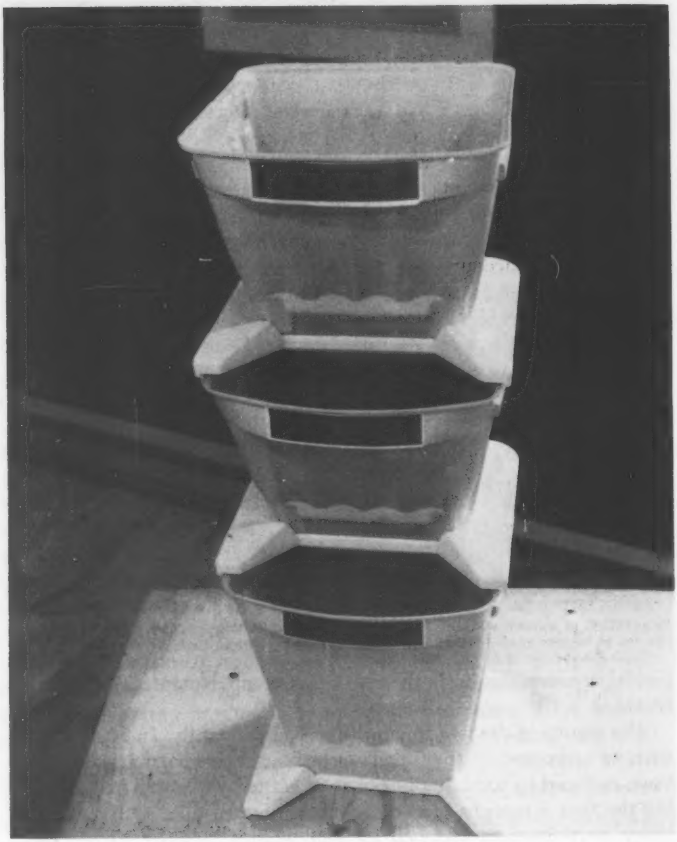
Integration of source separation into a city's main refuse disposal system generally results in higher participation rates. Photographer: Daniel Brody.

picked up weekly in both towns by compartmentalized garbage trucks.[53]

The results in the two towns differed significantly. In Marblehead, with an estimated 75 to 80 percent of households participating,[54] the town reduced its total amount of solid waste by 23 to 33 percent during the first 9 months of the program.[55] Somerville, with somewhat lower participation, reduced its solid wastes by 7 to 10 percent.[56] During this period, Marblehead's net savings, counting money not spent on landfilling as well as revenues from materials sales, were approximately $3,000 per month. Even at its lower participation rate, Somerville's net savings in some months ran as high as $1,700, but overall the town approximately broke even for the 9-month period.[57]

The Somerville program was discontinued within the year. According to EPA, its demise was due partly to political problems between the mayor and the sanitation union that produced strikes and disrupted the project [58] and partly to several severe snowstorms that so taxed city manpower that wastes could not be collected separately. Both factors may have led Somerville residents to lose faith in the project. However, the Marblehead program, now in its fourth year of operation, continues to achieve a 25 percent reduction of wastes.[59]

The results of this test might seem to suggest that source separation programs do better in areas populated by relatively well edu-



Compartmentalized waste containers make household separation of wastes easier.

cated, high-income citizens. However, the experience of the town of Nottingham, N.H., a rural area with relatively low average income and education levels, contradicts this conclusion. Many other factors—from degree of public involvement in the decision to effectiveness of publicity efforts—may be important to a program's success.[60]

COST AND MARKET PROBLEMS

Besides possible difficulties with participation rates, source separation programs also face problems in keeping down costs and obtaining markets for their recycled materials. Municipal source separation programs are seldom profitmaking enterprises on the basis of the materials recovered alone. The cost of collecting, sorting, and baling the recyclables generally exceeds the revenues from their sale. Source

separation is an economically viable proposition for most towns that have instituted it because it is a cheaper way of getting rid of wastes than operating a sanitary landfill or town incinerator. The costs of collection and sorting are thus balanced by revenues from sales of materials plus savings from not having to landfill these materials.

Cost factors for the town of Marblehead, which recovered about 200 tons of waste per month, are shown in Table 4–4. The table shows that, for most months, the cost of operating the source separation program ("incremental collection costs"), including capital, labor, and collection costs, after revenues from sale of recyclables are taken into account, is less than $5 per ton of recycled waste. Because Marblehead would have had to pay nearly $19 a ton to have those wastes landfilled, the source separation program was competitive with the alternative disposal method.[61] A regional source separation program serving the University of New Hampshire and several surrounding towns incurred similar costs: approximately $7 per ton of waste processed, after revenues were counted.[62] With the average cost of disposing of a ton of waste in a landfill expected to rise from around $5.50 to about $10 per ton as environmental standards tighten, source separation—even if it cannot pay for itself—should become an economically attractive disposal solution in more and more places.

Table 4–4

Marblehead Program Economics, January-September 1976

(in dollars)

Month	Incremental Collection Costs *	Revenues From Sales	Diverted Disposal Savings	Net Savings
January (12-31)	2,930	1,870	2,990	1,930
February	3,570	2,560	3,390	2,380
March	4,450	3,790	3,680	3,020
April	4,470	3,500	3,640	2,670
May	3,850	3,400	3,390	2,940
June	4,240	3,730	3,850	3,340
July	4,040	3,280	3,350	2,590
August	4,240	4,340	3,850	3,950
September	4,050	3,360	3,580	2,890

* Includes labor costs as well as operation, maintenance, and capital amortization for the compartmentalized trucks and all other equipment added as a result of the source separation program.

Source: U.S. Environmental Protection Agency, Fourth Report to Congress, *Resource Recovery and Waste Reduction* (Washington, D.C.: U.S. Government Printing Office, August 1, 1977), p. 35.

The major operating costs of a source separation program are generally collection of the separated wastes, and operation of the recycling center. Collection may be made either by separate trucks (in which case extra workers may have to be hired to make the rounds) or by normal garbage collection, with modified trucks. The latter option is generally cheaper, but problems can develop because

progress over a route is slower, or because one truck compartment fills up faster than another.[63] Collection problems can be complicated by local scavengers who sometimes take newspapers put out for municipal pickup. Several communities have had to pass anti-scavenger ordinances.

A greater source of difficulty to many programs is obtaining adequate markets for materials collected. Prices for recycled materials are subject to wide and sudden swings. It is, therefore, critical to the success of any recycling program to develop contractual arrangements for purchase of its recycled materials. Cities that pass recycling ordinances and fully integrate source separation into their waste disposal system do seem to be able to find contractors willing to guarantee them a floor price for their recyclables, generally with an escalator clause tied to spot market prices. In return, the contractor is assured a stable supply of materials delivered in a known, reliable form. Marblehead's guaranteed floor prices in 1976, for example, were $5 per ton for paper, $12 per ton for glass, and $10 per ton for cans.[64]

LONG-TERM PROSPECTS FOR MARKETS

Obviously, however, these prices are very low. At this point the likelihood of their increasing, or of U.S. industries absorbing significantly larger quantities of recyclables, is highly uncertain. Currently, most U.S. industries are set up to make their products from virgin raw materials. In the paper industry, the percentage (though not the actual tonnage) of paper products made from recycled fiber actually decreased since World War II, from 30 percent of the total in 1950 to about 22 percent in 1977.[65] According to an analysis by EPA, most paper producers favor using virgin pulp, and waste paper prices have risen dramatically only in periods when, for one reason or another, virgin pulp was in short supply.[66]

Increased paper recycling is technically and economically feasible. Only about 12 percent nationally of all newsprint is made from recycled newspapers,[67] yet one company operates three mills that make newsprint from nothing but recycled fiber. The company, Garden State Paper, supplies newsprint to the *New York Times* and *Washington Post,* among others, and was scheduled to open a new facility in Georgia in 1979. The company has shown that the recycling process can save energy and generate less air and water pollution than conventional newsprint plants.[68] Nevertheless, it appears that for the present, the amount of paper being recycled is limited not by insufficient supply, but by lack of paper industry demand.[69]

Much the same situation appears to hold true in the iron and steel industry. Less than 10 percent of all steel produced in this country is currently made from scrap steel that has gone through a cycle of use,[70] and almost all of this amount represents industrial rather than consumer waste.[71] A study conducted for the Institute of Scrap Iron and Steel indicates that at present rates of scrap use, there is a 14-

Labor costs are often a significant component of the total cost of a source separation program. Photographer: Daniel Brody.

The market for recycled iron is not strong. There is a 14-year backlog of scrap at junkyards across the country. Photographer: Daniel Brody.

year backlog of scrap iron available for recycling at junkyards and other locations around the country.[72] Steelmaking technology is such that some furnaces could accept more scrap. But using scrap adds uncertainties and potential problems to the steelmaking process in the form of possible contamination with dirt, plastics, aluminum, and other metal impurities that steelmakers would just as soon avoid.[73]

In the aluminum industry, the long-term outlook for markets for recycled materials is more encouraging. The reason is simply and clearly the energy crisis. Although it takes two to four times as much energy to make steel from virgin materials as from recycled materials,[74] it takes at least 20 times as much energy to make new aluminum as to recycle it.[75] As a consequence, the aluminum industry has been paying up to $400 a ton for aluminum cans,[76] as opposed to the $20 per ton generally offered for steel cans.[77] There are no backlogs of aluminum cans for recycling, and it appears that the industry will be willing to purchase as much aluminum as source separation systems can supply.

The market for glass may strengthen. One company has pioneered new techniques in making recycled glass. Photographer: Daniel Brody.

The market in glass is nowhere near as strong, but may strengthen. At present, only 3 percent of glass production uses recycled raw materials.[78] However, one company, Glass Container Corp., has pioneered new techniques in making recycled glass and operates regularly using 50 to 60 percent consumer "wastes." [79]

For source separation to grow as a waste disposal method in the United States, long-term markets will have to be found for the systems' products. It is presently not certain whether those markets will exist in the paper, steel, or glass industries. To some extent, this is a chicken-and-egg problem. Industry spokesmen commonly cite lack of reliable sources of supply as one of the reasons for setting up their processes to use virgin rather than recycled raw materials. An analysis by the U.S. Congress' Office of Technology Assessment asserts that, at present, neither the paper nor glass industry is technically equipped to absorb the full amount of these materials potentially recoverable from municipal solid waste.[80]

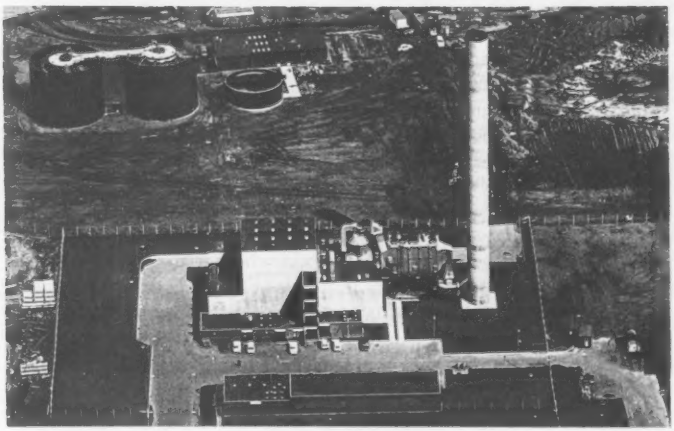
CENTRALIZED WASTE PROCESSING

CURRENT STATUS

In a central resource recovery scheme, household and commercial wastes are taken to a waste processing facility, rather than a commercial incinerator, landfill site, or recycling center. At the processing plant, the waste is generally burned and the heat energy used to make steam, which may in turn be put to a variety of uses, from space heating to industrial processes to generation of electricity. Steel cans and possibly other materials may also be recovered from the waste, either before or after incineration.

Interest in this technology began in Western Europe in the 1950s and 1960s as an adjunct to efforts to reduce waste volume via incineration. A number of these countries now feed from one-third to one-half their municipal waste through such plants.[81] The United States, with its cheaper energy prices and greater availability of land for dumping, has been slower to take advantage of the technology. Only three centralized waste processing facilities, two in New York state and one at a U.S. Naval Station in Virginia, were built in this country before 1970.[82] But interest has grown. As Table 4–5 indicates, the General Accounting Office was able to identify 20 trash-to-energy plants in operation and another 10 under construction at the end of 1977.[83] Advanced planning had been completed for 30 more, and preliminary planning had begun on another 70 facilities.[84]

As noted earlier, the 20 operating facilities process only about 1 percent of the nation's municipal solid waste.[85] If they were operating at full capacity, however, and if all 40 plants under construction or in advanced planning were complete and operating at full capacity, they could be extracting energy from about 10 percent of the



Refuse-burning district heating plant in Horsens, Sweden. Some European countries convert over a third of their municipal solid waste to energy.

country's waste, or 18 million tons per year.[86] If all 70 plants now in the preliminary planning stage were also built, this figure could be doubled, and the nation could be processing close to 20 percent of its municipal waste.[87]

ADVANTAGES

The advantages of energy and material recovery are clear. First, the weight and volume of wastes to be landfilled is drastically reduced. Though there is some variation depending on how well nonburning materials such as glass and cans are removed, the amount left over after processing is no more than 10 percent by volume, and 25 percent by weight of the original.[88] This residue is sanitized and is largely inert.

The second important benefit of operating such facilities is the energy they can recover. Not all municipal solid waste is, from a practical point of view, available for energy recovery. EPA estimates that perhaps 75 percent of all municipal waste is generated in areas with sufficient population density that the cost of transporting wastes to a central processing facility would not be prohibitive.[89] The agency calculated in 1973 that the maximum possible energy yield from this trash was about 900 trillion Btus, or the equivalent of 424,000 barrels of oil per day. That amount is equal to about a quarter of the 1979 flow of the Alaska pipeline and is enough energy to meet the home and office lighting needs of the entire nation.[90] Total gross discards have risen by 10 percent since EPA made the estimate; the amount of energy potentially available from trash should have risen proportionally.

A third possible benefit of centralized resource recovery is its potential for producing iron, steel, aluminum, glass, and even paper from waste for recycling. Iron-bearing items, including cans, broken appliances, nails, pails, and drums, are easily removed from garbage by magnets. The technology for iron recovery is not new; it has been used for years at landfills, junkyards, and elsewhere.[91] However, as noted earlier, the current market for iron is not good.

The market for aluminum is better, but the technology for recovery in processing plants is more complex and less advanced. In the case of glass, both markets and recovery technology are poor. Various ingenious schemes involving blowers, electrical charges, and air bubbles in water have been tried for separating aluminum and glass from wastes.[92] A few such systems have been incorporated in some of the plants now operating or under construction, including those in Bridgeport, Conn.; Ames, Iowa; and Milwaukee, Wis.[93]

Both glass and aluminum recovery systems have consistently suffered from technical deficiencies—chiefly, a low recovery rate and a recovered product containing significant amounts of impurities and contaminants.[94] The Office of Technology Assessment reports efficiencies of 50 to 70 percent (see Table 4–6). In several cases, owners of installed systems have not used them because they cannot find a market for their product.

Table 4–5

Summary of Urban Waste-to-Energy Projects in the United States, in Operation and Under Construction, 1977

Systems in Operation (20)								
Project Location	Process Type	Capacity (TPD) [a]	Energy Form Produced	Other Resources Recovered	Starting Date	Market for Energy Form	Cost (million dollars)	Owner/Operator
Ames, Iowa	RDF [d]	400	RDF	Paper, Fe, and Al [b]	9/75	Ames Municipal Power Plant	6.3	City of Ames
Baltimore, Md.	Pyrolysis	1,000	Gas to steam	Fe, Glass Agr.[c]	6/75	Baltimore Gas and Electric Co.	25.0	City of Baltimore
Baltimore County, Md.	RDF [d]	400 to 1,200	RDF	Fe, Al, glass	4/76	TBD [e]	10.0	50% Baltimore County, 50% State of Md./Teledyne
Blytheville, Ark.	MCU [f]	50	Steam	None	11/75	Metal plating industry	0.8	City of Blytheville
Braintree, Mass.	RWI/WWI [g]	240	Steam	Fe	9/70	Weymouth Art and Leather Co., and Sigma Industries	3.0	City of Braintree
Chicago, Ill. (NW)	WWI	1,600	Steam	Fe	Spring 1972	Industrial park	30.0	City of Chicago
East Bridgewater, Mass.	RDF	1,200	RDF	Fe	8/76	Utility plant	14.0	East Bridgewater Associates/Combustion Equipment Assn.
El Cajon, Calif. (San Diego County)	Pyrolysis	200	Oil	Fe, Al, glass	12/77	San Diego Gas and Electric Co.	14.5	San Diego County

Groveton, N.H.	MCU	30	Steam	None	10/75	Diamond International Paper Co.	0.3	Diamond International
Harrisburg, Pa.	WWI	720	Steam	Fe	10/72	Pennsylvania Power and Light	2.8	City of Harrisburg
Lane County, Oreg. (Eugene)	RDF	500	RDF	Fe	12/77	Eugene Water and Electric and Univ. of Oregon	3.5	Allis Chalmers Corp. Western Waste Corp.
Milwaukee, Wis.	RDF	1,600	RDF	Paper, Fe, Al, glass agr.	5/77	Wisconsin Electric Power Co.	18.0	American Can Co.
Nashville, Tenn.	WWI	720	Steam	None	7/74	Building complex	26.5	Nashville Thermal Transfer Corp.
Norfolk, Va.	WWI	360	Steam	None	6/67	U.S. Navy Base	4.3	U.S. Navy Public Works
North Little Rock, Ark.	MCU	100	Steam	None	9/77	Koppers Co.	1.5	City of North Little Rock
Palos Verdes, Calif.	Methane recovery	1.1 MMCF/D	Methane gas	None	6/75	So. Calif. Gas Co.	1.5	Reserve Synthetic Fuel Co.
Portsmouth, Va.	WWI	160	Steam	Fe, Al	8/77	U.S. Navy Base	4.5	U.S. Navy
Saugus, Mass.	WWI	1,200	Steam	Fe	10/75	General Electric Co.	38.3	RESCO (Joint venture of De Matteo Construction Co. and Wheelabrator-Frye, Inc.)
Siloam Springs, Ark.	MCU	20	Steam	None	9/75	Canning plant	0.4	Town of Siloam Springs
Tacoma, Wash.	RDF	500	Steam	Fe	12/77	TBD	3.0	City of Tacoma

See footnotes at end of table.

Table 4–5 (continued)

Systems Under Construction (10)

Project Location	Process Type	Capacity (TPD) [a]	Energy Form Produced	Other Resources Recovered	Starting Date	Market for Energy Form	Cost (million dollars)	Owner/Operator
Akron, Ohio	RDF	1,000	Steam	Fe, non-Fe	12/79	B. F. Goodrich Co., Univ. of Akron	46.0	City of Akron/ Teledyne
Albany, N.Y.	RDF	1,200	RDF	Fe	5/79	N.Y. State Office of General Services	11.0	City of Albany and N.Y. State
Bridgeport, Conn.	RDF	1,800	Powdered RDF	Fe, Al, glass	3/78	United Illuminating	53.0	Occidental Petroleum Corp. and Combustion Equipment Assn.
Chicago, Ill. (Crawford)	RDF	1,000	RDF	Fe, non-Fe	3/78	Commonwealth Edison	19.0	Commonwealth Edison
Hempstead, N.Y.	RDF	2,000	Steam	Fe, Al, color-sorted glass	5/78	Long Island Lighting Co.	81.0	Hempstead Resources Recovery Corp. (Div. Black Clawson/Parsons and Whittamore, Inc.)
Jacksonville, Fla.	MCU	50	Steam	Fe	3/79	U.S. Navy Base	2.0	Scientific Energy Engineering
Monroe County, N.Y.	RDF	2,000	RDF	Fe, non-Fe, mixed glass	Late 1978	Rochester Gas and Electric Co.	50.4	Monroe County/ Raytheon
Mountain View, Calif.	Methane recovery	1 MMCF/D	Methane gas	Fe, paper, glass	7/78	Pacific Gas and Electric	0.7	Pacific Gas and Electric

Redwood City, Calif.	Pyrolysis	100	Gas to Steam	Fe	5/78	Pacific Gas and Electric	1.0	Redwood City/Bayside System Authority
Western Lake Superior District (N.E. Minn.)	RDF	400	RDF	Fe	12/78	Negotiating with Duluth Transit Co.	60.0	Western Lake Superior Sanitary District

[a] Tons per day.
[b] Fe=Ferrous metals; Al=Aluminum.
[c] Glass agr.=glass aggregate.
[d] Refuse-derived fuel.
[e] To be determined.
[f] Modular combustion unit.
[g] RWI=refractory wall incineration; WWI=waterwall incineration.

Source: General Accounting Office, *Conversion of Urban Waste to Energy: Developing and Introducing Alternate Fuels from Municipal Solid Waste* (Washington, D.C.: U.S. Government Printing Office, February 28, 1979), p. II-2; and Council on Environmental Quality.

Table 4–6

Material Recovery Efficiencies at Centralized Waste Processing Facilities

Material/Technology	Estimated Achievable Efficiency of Recovery Technology (in percent)
Ferrous/magnetic	90–97
Paper/wet slurry	50
Aluminum/magnet	55
Glass/froth flotation	65–70
Glass/optical sorting	50

Source: U.S. Congress, Office of Technology and Assessment, *Materials and Energy from Waste*, final draft (Washington, D.C.: U.S. Government Printing Office, June 1978), pp. 6–11.

At one test facility, the potential for recovering paper from wastes for industrial use has been demonstrated. At the EPA-sponsored facility in Franklin, Ohio, garbage was turned into a wet slurry, and paper fibers recovered from it, for use in making felt roofing shingles.[95] However, the very small output of this test facility (it processed only about 25 tons of waste a day) eventually led the shingle plant to terminate its purchasing arrangement, and in March 1979 the Franklin plant closed.[96]

Despite technical problems with glass and aluminum recovery, centralized waste processing systems seem to be eminently worthwhile methods of obtaining energy and conserving landfill space What, then, is preventing cities, utilities, and private trash disposal companies from adopting them widely and rapidly? There is no single answer, but rather a broad range of potential problems, some technological, some institutional, and some economic, that can stymie progress.

TECHNOLOGICAL BARRIERS

Technological barriers are probably the least serious obstacle to wider resource recovery at this time. Problems can be minimized by employing proven, relatively simple trash-to-energy systems now in use in both Europe and the United States. The "workhorse" of trash-to-energy is the waterwall incinerator, and 7 of the 20 operating U.S. facilities are of this type.[97] The sides of the incinerator are lined with pipes for water to pass through. When waste is being burned in the incinerator, the exhaust gases heat the water in the pipes. The hot water is used to make steam, which can then be used to heat homes or offices, generate electricity, or run industrial processes. A 1,200-ton-per-day waterwall incinerator plant in Saugus, Mass., began operation in 1976 and processes the wastes of a dozen Massachusetts communities. The plant sells steam heated to 845° F to General Electric for all three uses listed above.[98]

A second reliable technology for recovering energy from wastes is the modular incinerator. These "packaged" units are small, factory-made incinerators equipped with waste heat boilers. The boilers capture the heat from the incinerator's exhaust gases, which may then be used for the same purposes as outlined above. However, modular units are not as efficient at recovering heat as the waterwall incinerators.

The main advantages of these units are their small size and relatively low cost. This makes them suitable for small-scale and small-town use. The smallest of the waterwall facilities is a 175-ton-per-day plant operating at the U.S. Navy base at Portsmouth, Va.; however, economic concerns usually dictate waterwall plants in the 1,000-ton-per-day range. The larger size facility requires the wastes of at least half a million people to run at full capacity. However, modular incinerators processing as little as 20 to 40 tons per day have been built in such places as Siloam Springs, Ark., Groveton, N.H., the John Deere plant in Dubuque, Iowa, and at the Pentagon.[99] Four of the country's 20 municipal trash-to-energy facilities are of this type, and perhaps several dozen more such units are being employed in factories and various institutions.[100]

A third proven technology for extracting energy from garbage is to convert a major portion of the trash to a fuel that can be burned not only in incinerators but in standard utility and industrial boilers as well. This fuel has been dubbed refuse-derived fuel, or RDF.

Both waterwall and modular incinerators can handle unprocessed wastes. Garbage is simply dumped in the incinerator and burned. The leftover ash is landfilled. However, to improve efficiency, allow production of hotter steam, and permit extraction of recyclables, some American builders and operators of such systems have felt it desirable to process wastes before feeding them into waterwall incinerators. The technology for this process is fairly reliable, and involves reducing all garbage to small pieces so that nonburnable materials such as glass and metal can be removed before incineration. The size of the pieces is reduced by various processes including shredding, milling, flailing, trommeling, and screening. As of the end of 1978, no such facilities were in operation, but five were under construction.[101]

Such processed wastes can also be burned in electric utility boilers. The pioneer in this field was the EPA-sponsored facility which supplied wastes to Union Electric in St. Louis, Mo. It operated on an experimental basis for 4 years. Six of the 20 operating facilities now use this technology.[102] At the St. Louis-type plants, waste is first shredded. It then passes through blowers that separate the light materials—generally easy-to-burn materials like pieces of leaves, plastic containers, paper, and food—from the heavier materials, such as hard-to-burn items like bottles and cans. The lighter fraction becomes the RDF. At St. Louis, it was burned, together with coal, in Union Electric's boilers. The heavier portion, after recovery of iron-bearing wastes, was landfilled.[103]

A variant of this technology is production of "wet RDF." Originally tested at the Franklin plant in Ohio as a means of recovering paper fiber, it involves reducing all wastes to a wet pulpy mass. This mush is then fed into a cyclone and spun around. Centrifugal force separates the lighter from the heavier materials.[104] The lighter fraction is then partially dried and burned in specially designed boilers to produce energy.

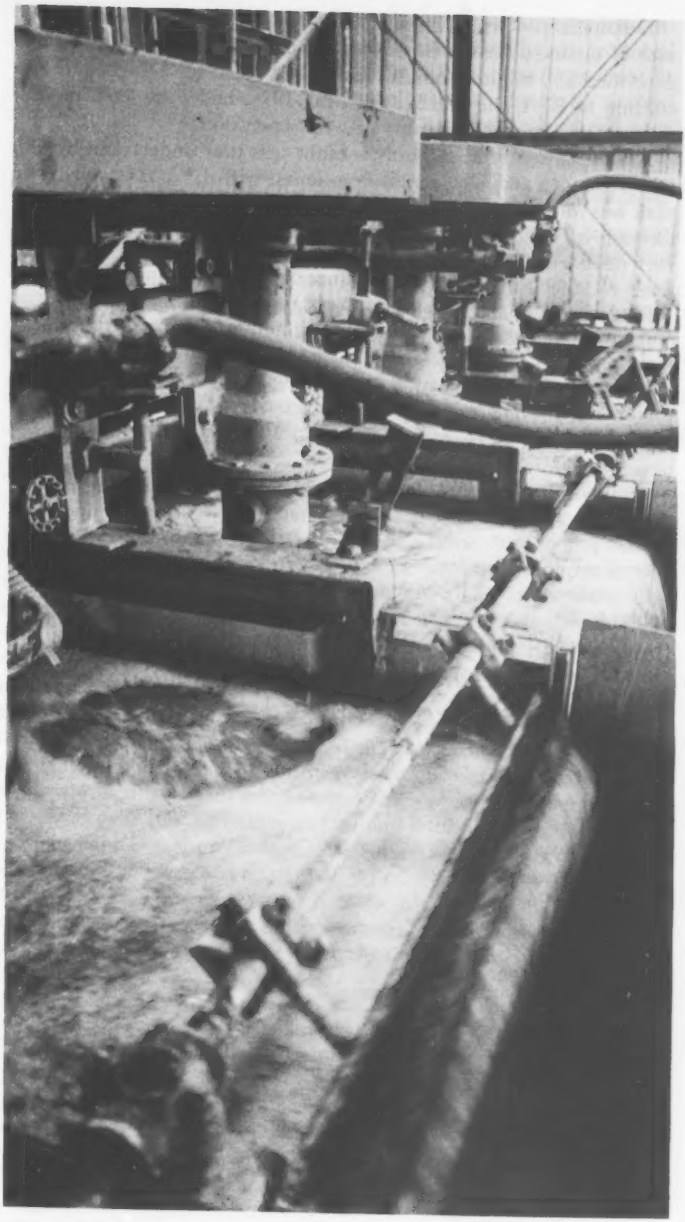
A plant that produces dry RDF, rather than one that burns waste for steam, has the advantage of making a transportable energy product that can be burned in a pre-existing energy plant. However, because dry RDF is highly flammable and subject to spontaneous combustion, it generally must be burned in the immediate vicinity of the trash-to-energy facility. This also minimizes transportation costs.

If one of these relatively well-developed technologies is not employed, serious technical difficulties are far more likely to arise. As noted earlier, systems to extract glass and aluminum from trash are desirable because they make valuable materials available for recycling, but they are hampered by technical problems. Even more serious technical problems have developed with plants designed to turn garbage into oil or gas. If these fuels could be produced successfully, they would, of course, be even more useful and versatile than dry RDF.

The city of Baltimore, with federal help, was the first to attempt to build a commercial-scale trash-to-gas plant using a technology called pyrolysis. In 1972, Baltimore contracted with Monsanto Enviro-Chem Systems, Inc., to build a 1,000-ton-per-day pyrolysis facility at a cost of $16 million. The gas produced was to be burned to make steam, which Baltimore Gas and Electric would purchase for heating and cooling large buildings in the downtown area.[105] The immediate impetus for the plant was the fact that the city's landfill capacity was virtually exhausted.[106] The federal government, through an EPA grant, contributed $7 million toward the cost.[107]

The plant, scheduled to go into full operation in 1975, has experienced an enormous number of difficulties, and 4 years later was still undergoing modifications projected to total over $4 million.[108] In principle, the plant was supposed to operate by passing wastes through a shredder and then feeding them into a large kiln, where at temperatures of 2000° F the organic material in the garbage would break down into the burnable gas.[109]

It appears that everything has broken down but the garbage. A Congressional Research Service report noted the following problems: the conveyor systems failed to function properly; the lining of the kiln broke up and fell out; a fan controlling the movement of the gases suffered uncorrectable vibration problems; the gas burner was half as big as needed; and the waste hopper did not work as designed, to a point where on at least one occasion solidified garbage had to be blasted out with dynamite.[110] The worst problem was the failure of the air pollution control system, which finally required the purchase of a new electrostatic precipitator at a cost of $1.2 million.[111]



Experimental flotation cells for extracting glass from wastes. Photographer: Perry Bagalman.

Despite its problems, the plant had, by early 1978, processed 70,000 tons of waste in the course of its intermittent operation. It had also generated 250 million pounds of steam that sold for $750,000.[112] According to EPA, the plant, as of May 1979, had completed modifications and was just beginning new test operations.[113]

Another attempt at a pyrolysis plant was that undertaken by San Diego County and Occidental Petroleum, with EPA assistance. The plan was for a 200-ton-per-day plant to convert waste to a form of oil through a "flash" pyrolysis process. The plant, completed in 1976, was designed to shred wastes to dust-like fineness and then heat them to 900° F in less than 2 seconds in a vertical shaft.[114]

Shakedown operations, begun in December 1977, ran into numerous mechanical problems.[115] As of mid-1979 the plant's future was uncertain. This plant was designed to be a test facility and, according to the Congressional Research Service (CRS), requires sophisticated personnel to run it. The CRS feels that a facility of at least 1,000-ton-per-day capacity, costing about $50 million, would be required for it to be economical.[116]

Another drawback of these complex processing systems, beyond the technical difficulties, is that the net energy recovered decreases as the amount of processing increases, because of the additional energy requirements. As Table 4–7 indicates, solid refuse-derived

Table 4–7

Comparison of Energy Recovery Efficiencies for Selected Solid Waste Energy Recovery Processes

(percent of higher heat value contained in input solid waste)

Process	Net Energy in Fuel Produced [a]	Net Energy Available as Steam [b]
Fluff RDF	• 70	• 49
Dust RDF	80	63
Wet RDF	76	48
Waterwall combustion furnace	—	59
Modular incinerator	—	• 25–50
Purox gasifier	64	58
Monsanto gasifier	78	42
Torrax gasifier	• 84	• 58
Occidental Petroleum Co. pyrolysis	26	23
Biological gasification [d]	• 33	• 29

[a] This is the higher heating value of the fuel product less the heat value of the energy used to operate the system (in the case of electric power consumption it was assumed that the electricity was produced on site using the system's fuel product), expressed as a percent of the heat value of the solid waste.

[b] In order to compare all the processes on an equal basis, the net energy available as steam was calculated using the boiler efficiency for each fuel product.

• Updated figure drawn from U.S. Congress, Office of Technology Assessment, *Materials and Energy from Waste,* final draft (Washington, D.C. June 1978), pp. 6–12.

[d] Includes energy recovered from sewage sludge.

Source: U.S. Environmental Protection Agency Publication SW–157.2, 1976. All calculations based on solid waste input at 5,000 Btu per pound (higher heating value) with some inorganic materials removed.

fuel that is produced by mechanical means is more energy-efficient than liquids and gas from pyrolysis. But the gas or liquid produced would be expected to sell for a higher price and, therefore, might be economically justified if the technical problems could be worked out.[117]

POLLUTION AND WORKERS SAFETY AND HEALTH PROBLEMS

A final area of technological uncertainty for all trash-to-energy plants relates to potential pollution and occupational safety and health problems. To date, operating facilities appear able to meet current state and EPA standards for particulates and for sulfur dioxide and nitrogen oxide emissions, although at some sites this has been at considerable expense and after much effort. Trash-burning plants also have certain very appealing environmental characteristics when compared with other energy facilities. They produce no radioactive wastes. Nor do they emit large quantities of sulfur dioxide, since the sulfur content of municipal waste is between 0.1 and 0.2 percent, compared with the troublesome 2.5 to 3.5 percent sulfur content of most power plant coals.[118] Nevertheless, trash-to-energy plants do emit measurable quantities of fine particulates, certain potentially hazardous organic compounds, viruses and bacteria, and toxic elements such as cadmium, lead, and mercury. The latter toxic substances occurred in higher concentrations in the refuse-derived fuel than in the coal at the St. Louis demonstration plant.[119] Leaching of toxic heavy metals such as arsenic and cadmium from residues and ash that are landfilled may also prove to be a problem.[120] Health hazards, such as harmful dusts and vapors, infectious disease or viruses, and excessive machine noise, may also occur inside the facilities. Noise levels of up to 108 dBu were recorded inside the St. Louis facility.[121] Furthermore, as of early 1979, existing facilities had experienced over 100 explosions and a number of fires. Most of the explosions caused serious damage to buildings and equipment, injuries to employees, and at least one death.[122] Much more needs to be known both about the potential hazards to health inside such plants and about the levels at which hazardous substances are emitted from waste processing facilities before the extent of the pollution hazards can be accurately assessed.

MARKET PROBLEMS

Technical difficulties constitute only one obstacle to wider use of centralized resource recovery. Despite our current energy crunch, a second important problem is finding appropriate markets for the steam or fuel produced. One reason for this, according to an analysis by the Office of Technology Assessment, is that a reasonable size for a centralized resource recovery facility, in terms of the amount of waste generated by a moderate-sized city, is an extremely awkward size in terms of finding markets for potential energy products.[123] It

appears that an "average" size for a new waterwall incinerator is in the neighborhood of a 1,000-ton-per-day capacity. Such a facility can process the wastes of about 600,000 people.[124] The United States has approximately 70 metropolitan areas of this size or larger.[125] The economics of building and operating such a plant seem to work out well.[126]

A plant of this type and size could be used to produce electricity. However, the 37 megawatts of power it could generate would satisfy the needs of only 3 percent of 600,000 people. Many electric utilities see this as too small a contribution to justify the effort and cost of adopting a new technology. On the other hand, the energy output from a 1,000-ton-per-day plant is much too large for most alternative customers for the steam or hot water. A plant of this size, for example, could serve the heating and cooling needs of 5 million square feet of office space. The Pentagon, one of the world's largest office buildings, has 6.5 million square feet; the U.S. Capitol has only 0.75 million square feet.[127]

A municipality that wants to build a centralized recovery facility thus faces several choices, none of which is completely satisfactory: build much smaller units with lower energy efficiency and the proliferation of siting and logistics problems; experiment with one of the less technically reliable methods of producing solid, liquid, or gaseous fuels; find industrial customers whose needs match the energy production of a larger plant; or line up a series of customers for the steam. One city that adopted the last course is Nashville, Tenn. The experience of that city, which was ultinately successful, illustrates still another area of problems for centralized resource recovery that can only be described by the vague term "institutional."

INSTITUTIONAL BARRIERS

American political and business institutions are structurally ill-adapted to centralized resource recovery. In most cities wastes are collected by the municipality, although some types of waste, e.g., commercial, and some portions, e.g., from unincorporated suburbs, may be collected by private haulers. The makers of recovery systems are, of course, private, while the most likely buyers of the recovered energy—electric utilities—are private concerns heavily regulated by government agencies unrelated to the cities.

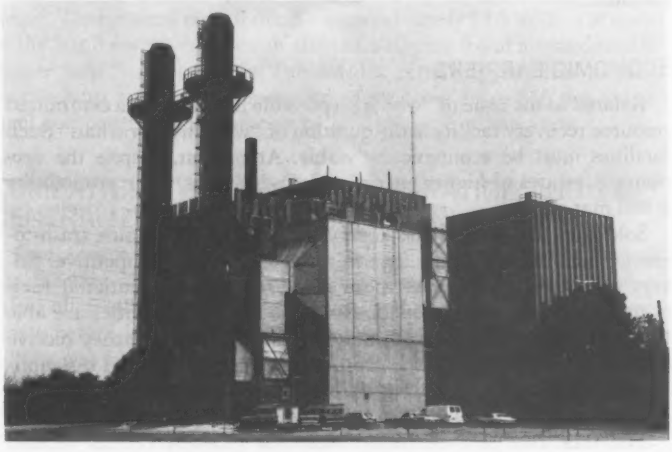
Getting all the relevant institutions to cooperate successfully on a major resource recovery project is a formidable task. It can be difficult, for example, to round up enough wastes from various disposers to make a plant economically viable. Usually, some entity must be found or created to operate the facility. The engineering firms that construct the plants usually want to sell them and go on to build more plants. The firms that formerly disposed of wastes—haulers and landfill operators—have no expertise in operating a large, high-technology energy plant. City sanitation departments likewise are ill-suited for such a complex business and engineering venture.

Furthermore, in the interests of preventing misspending of public funds, city and state charters sometimes prohibit these entities from entering into longer than 1-year contracts for buying or selling of goods and services, making it extremely difficult to plan or to involve private businesses in such facilities.[128]

Finally, the utilities, which might logically be the best market for the energy produced and are prime candidates for owning and operating recovery facilities, appear loath to get involved. Many of the reasons relate to the way in which they are regulated. Many utilities are allowed to pass fuel price increases directly on to consumers through "fuel adjustment clauses." Such clauses reduce the incentive to use cheaper fuels. Utilities are also required by law to provide reliable service, something that discourages them from experimenting with technologies that have not been proven beyond all possible shadow of doubt, especially when the technology can make only a modest contribution to a utility's total output.

The city of Nashville dealt with a number of these institutional problems in an unusual and interesting way. As part of a downtown renewal program, Nashville decided in the late 1960s to create a district heating and cooling system for public and private buildings in the central city area. The city solved the "who should do it" problem by creating a not-for-profit corporation called Nashville Thermal Transfer Corp. to build and operate the system. The city then decided to fuel the plant with wastes, thereby solving another city problem. After due study, Nashville Thermal became a refuse disposal organization as well as a heating and cooling utility.[129]

Nashville Thermal eventually built a 720-ton-per-day waterwall incinerator facility designed to handle only a portion of the city's



The city of Nashville, Tenn., solved several problems at once when it created the Nashville Thermal Transfer Corp., an independent, not-for-profit corporation, to build and operate this trash-burning district heating and cooling plant.

wastes.[130] The plant began operating in 1974 and was subsequently upgraded to a 1,060-ton-per-day capacity.[131] The system serves 30 buildings [132] and processes a quarter of Nashville's wastes. Its relatively modest size obviated a number of potential pitfalls. For example, the system has had sufficient amounts of waste to process, in contrast to several others, including those in Ames, Iowa, and Saugus, Mass., where waste volume did not meet projections.[133] In addition, seasonal fluctuations in volume of waste could be accommodated by varying the amount of waste delivered to the landfill.[134]

By creating an independent not-for-profit corporation to process wastes and distribute steam, Nashville avoided many of the institutional problems involved in trying to pull numerous disposal entities, an entrenched bureaucracy, and conservative utilities together for an experimental venture. Nevertheless, the project did suffer as a result of another institutional difficulty: the need for government entities to let contracts at the lowest possible cost. The Nashville plant experienced numerous technical problems in starting up, including such a serious malfunction of air pollution controls that a whole new system had to be added. Such problems did not occur at the Saugus plant, which is similar in design. An EPA assessment attributes the far poorer performance of the Nashville plant to cutting corners in the design of the project. A consultant's report states: "The critical problem was one not unique to waste processing facilities, but inherent in the low-bid requirements of government purchasing . . . . The lesson to be learned from Nashville is that a bargain in industrial equipment is a rarity." [135] Fortunately, it has proved possible to make the needed changes, and the plant now appears to be functioning reasonably reliably and within emission limitations.[136]

ECONOMIC BARRIERS

Related to the issue of "who is responsible for what" at a centralized resource recovery facility is the question of "who pays for what." Such facilities must be economically viable. At present, despite the economic pressures of higher energy and landfill costs, their profitability is still marginal.

Solely on the basis of the energy they produce, complex trash-to-energy facilities definitely are not yet economically competitive. Energy can still be produced more cheaply using conventional fuels burned in conventional boilers. Resource recovery facilities are able to break even or turn a profit only because the revenue they receive from sale of steam or fuels is supplemented by the amount the municipality pays them for getting rid of the wastes, known as a "tipping fee," plus any revenues from recovered materials.

The total cost of a centralized resource recovery facility consists of two components: capital costs and operating costs. Capital costs for such plants are high enough to strain the resources of many municipalities (see Table 4–5). The 2,000-ton-per-day Hempstead, N.Y.,

plant—the most expensive built to date—cost $81 million. A more typical figure for a 1,000-ton-per-day facility that produces an RDF fuel, but does not involve electricity generation equipment, is $25 million.

Table 4–8 presents the annual capital and operating costs, expressed in terms of cost-per-ton of capacity, for the Saugus, Mass., and Ames, Iowa, plants and estimates of projected costs for three other plants. The total annualized costs of the five plants range from approximately $15 to $23 per ton of refuse processed. A 1978 theoretical analysis of possible resource recovery options for the greater Kansas City area projects similar costs—in the neighborhood of $20 to $25 per ton—for the most cost-effective options for that area (see Table 4–9).

This, then, is the amount that must be recovered by a combination of energy sales, material sales, and tipping fees. The amount that can be charged in each category will vary greatly from place to place. A locality that is paying $20 per ton to landfill its wastes will obviously be willing to pay a much higher tipping fee than one that is paying $1 a ton for landfilling. Likewise, a recovery plant could probably charge more for steam in the Northeast, where energy costs are high, than in the Southwest, where fossil fuels are available more cheaply. The Kansas City study cited above estimated possible revenues from sale of steam in that locale of $18 per ton of waste processed. For the most cost-effective options, that amount would almost cover the cost of building and operating plants, and the operators could break even charging a tipping fee of only about $3 per ton. Such a result may not be too far off the mark. In Nashville, the city makes a lump sum contribution to the operation of the plant to make up the deficit not covered by revenues from sale of steam. That annual contribution—approximately $1.3 million in each of the last 3 years—is the equivalent of a tipping fee of approximately $8 per ton.[137] As shown in Table 4–10, actual tipping fees at four other plants currently in operation range from $8 to $15 per ton, a level competitive with the cost of landfilling in many areas.

COMPATIBILITY OF SOURCE SEPARATION AND CENTRALIZED RESOURCE RECOVERY SYSTEMS

Can source separation and centralized waste recovery coexist? On the face of it, it might appear that they are mutually exclusive. After all, if all the bottles, cans, glass, and paper are removed from waste before it is collected, then it would seem that centralized facilities will have little of value to recover or burn for energy. Some even argue that the economics of recovery plants is now so borderline that they could not tolerate even a small source separation effort. A bottle and can recycling program that was 50 to 90 percent effective might eliminate any revenues from materials recovery. A newspaper recycling program might lower the Btu content of the wastes to such a degree that the energy efficiency of the plant would be severely

Table 4–8

Summary of Annualized Costs of Selected Waste-to-Energy Processes

Project	Date of Capital Costs	Type of Process	MSW Capacity [a] (ton/day)	Investment (million dollars)	Annualized Capital Cost (dollars/ton)	Operating Cost (dollars/ton)	Total Annualized Cost (dollars/ton)
Saugus, Mass.	1975	Waterwall incinerator	1200	$37.5	$8.69	$9.16	$17.85
Ames, Iowa	1973	RDF	400	6.3	11.11	11.58	22.69
Milwaukee, Wisc. (projected)	1974	RDF	1600	11.7	7.09	9.75	16.84
Lorton, Va. (projected)	1974	RDF	750	6.9	3.39	15.18	18.57
	1974	RDF	1500	11.7	2.88	13.52	16.40
Edgemoor Delmarva, Del. (projected)	1974	RDF/Utility boiler	475	6.0	6.28	8.39	14.67

RDF = Refuse Denied Fuel
[a] Design capacity

Source: Gordian Associates, Inc., *Overcoming Institutional Barriers to Solid Waste Utilization as an Energy Source,* Prepared for U.S. Department of Energy, Division of Synthetic Fuels (Washington, D.C., November 1977), p. vi; and updated data supplied by DOE, August 1979.

Table 4–9

Projected Costs and Revenues for Energy Recovery Systems for the Kansas City Area, 1978

(in dollars per ton processed)

Type of System	Annual Cost [a]			Revenues	Net Cost
	Ownership	Operating and Maintenance	Total		
Modular Combustion Units [b]					
25 tons/day	$17.50	$23.41	$40.91	$18.00[e]	$22.91
50 tons/day	15.48	15.08	30.56	18.00[e]	12.56
100 tons/day	12.38	11.93	24.31	18.00[e]	6.31
200 tons/day	10.85	10.14	20.99	18.00[e]	2.99
Waterwall Combustion Unit [d]					
200 tons/day	16.27	12.68	28.95	18.00[e]	10.94
500 tons/day	14.34	8.75	23.09	18.00[e]	5.09
1500 tons/day	13.25	7.15	20.40	18.00[e]	2.40
Refuse-Derived Fuel System[e]					
500 tons/day	12.09	10.78	22.87	10.02[f]	12.85
1000 tons/day	10.78	9.33	20.11	10.02[f]	10.09

[a] Annual costs include interest on land, amortization of equipment, insurance, and operating and maintenance costs.

[b] Plants are assumed to operate at 95 percent of rated capacity, 5 days a week, 50 weeks a year.

[e] The plants are assumed to sell steam at $3 per thousand pounds in competition with fuel oil.

[d] Plants are assumed to operate at 78 percent of rated capacity, 7 days a week, 50 weeks per year. Capital investment was calculated at $43,370 per ton at 200 tons/day capacity; $38,157 per ton for 500 tons/day; and $35,187 per ton for 1500 tons/day.

[e] The system is assumed to operate at 85 percent of rated capacity, 6 days per week, 50 weeks per year. Capital investment includes modification of an existing boiler, and was calculated to be $32,102 per ton at 500 TPD capacity and $26,819 per ton at 1000 TPD capacity.

[f] The plants are assumed to sell RDF at $8.00 per ton. Ferrous and aluminum scrap are assumed recovered and sold.

Source: Black and Veatch and Franklin Associates, Ltd., "Detailed Technical and Economic Analysis of Selected Resource Recovery Systems," for the Mid-America Regional Council, 1978, Tables 1, 3, and 4.

Table 4–10

Tipping Fees at Selected Resource Recovery Facilities

Location	Normal capacity (TPD)	Technology	Tipping Fee (dollars/ton)	Date
Braintree, Mass.	240	Waterwall	8.00	Feb. 1979
Harrisburg, Pa.	720	Waterwall	12.60	July 1977
Milwaukee, Wis.	1,600	RDF	11.64	March 1979
Saugus, Mass.	1,500	Waterwall	14.58	March 1979

Source: Franklin Associates, Ltd., "Post-Consumer Solid Waste and Resource Recovery Baseline," Prepared for the Resource Conservation Committee (Washington, D.C., April 6, 1979), p. 55.

impaired. Finally, a source separation program that reduced the total volume of wastes by 25 to 50 percent might reduce the recovery plant's tipping fees to a point where it was no longer economically viable.

These problems of potential incompatibility are actually less serious than they appear. As explained above, the technology for extraction of recyclables, except for iron, is in its infancy for central resource recovery plants. At most such plants operating today, materials recovery contributes a very small amount to overall revenues.[138] Many plants burn wholly unprocessed wastes and do not recover any materials at all. Thus a bottle or can recycling program would generally not interfere, per se, with a centralized facility's economic position.

The question of whether the removal of paper and other recyclables from waste in a source separation program would seriously reduce the energy value of municipal wastes is a more open one. However, recent EPA data suggest that the impact would be minimal and, depending on the type of source separation program, might even be positive.

The reason for this is that recyclables in general, and newspapers in particular, actually constitute only a small portion of the burnable substances in refuse. Approximately 75 percent of all waste can be burned.[139] This includes everything from banana peels and plastic bags to old shoes and broken chairs. In general, newspapers, books, and magazines average only about 9 percent of municipal wastes.[140] According to EPA calculations, even an extremely effective newspaper recycling program would reduce the solid waste stream by no more than 7 percent, by weight, and the Btu value of the waste would decline by only 3.5 percent (see Table 4–11). If beverage container legislation significantly reduced the amount of bottles and cans in waste, the Btu value per pound of waste would actually *increase* by about 6 percent.

The third argument—that source separation could reduce tipping fee revenues at a centralized facility below the breakeven point—is more compelling. However, it holds true only under certain circumstances. It applies only when source separation is introduced after a centralized plant has been built, when the centralized plant in question is processing all of a region's waste, and when it has no access to additional wastes, either because transportation costs for such wastes would be too high or because political jurisdictional problems would be too great. In such a situation, the introduction of a source separation program would reduce the amount of wastes going to the centralized facility and thus its revenues from tipping fees (which are charged on a per-ton basis).

A plant that handled only a portion of a city's wastes would not, however, experience this problem. In the event that local source separation was instituted, or a national program of beverage container deposits or some other waste reduction measure took effect, such a plant could maintain the volume of wastes processed (and thus revenues) by increasing the proportion of the city's wastes it handled.

Table 4–11

Impact of Source Separation Options on Btu Content of Municipal Trash

Type of Source Separation Program	Average Btus per Pound of Trash	Percent Change
No source separation	4,600	—
High level, all wastes • (25% reduction in total waste stream)	4,660	+1.3
Low level, all wastes • (10% reduction in total waste stream)	4,510	−2.0
High level, newspaper (7% reduction in total waste stream)	4,440	−3.5
Low level, newspaper (3–4% reduction in total waste stream)	4,550	−1.1
Glass and cans (beverage container legislation)	4,890	+6.3

• All wastes defined as glass, cans, newspaper, office paper, and corrugated cardboard.

Source: U.S. Environmental Protection Agency, Office of Solid Waste, unpublished study, 1979.

Many people in fact now think that the best approach in developing a centralized recovery facility is to design the system to work in tandem with source separation at the outset. This would take advantage of the strengths of both systems: materials recovery from the source separation program and energy recovery from the centralized facility. If the source separation program did not materialize or proved less effective than hoped, it would mean a somewhat heavier load on the backup landfill site. However, EPA has pointed out that many other factors can also affect the amount of waste available to a plant, including seasonal fluctuations, jurisdictional problems, and the fact that many localities have only the roughest idea of how much waste they actually generate.[141] In general, EPA believes that it is better to plan conservatively and perhaps underbuild, than to build a centralized resource recovery facility that might eventually prove too large for the needs of the locality and, therefore, be uneconomical.

FEDERAL ACTIVITIES

Beginning with the Solid Waste Disposal Act of 1965[142] and continuing with the Resource Recovery Act of 1970[143] and the Resource Conservation and Recovery Act of 1976,[144] Congress has asked the federal government to attempt to do something about the nation's solid waste problems. These laws directed EPA to develop and to encourage use of better systems for disposing of solid waste, particularly where health hazards are involved. In addition, DOE has responsibilities for research, development, and demonstration of the energy potential of solid wastes.

The 1976 law created the Resource Conservation Committee, a special interagency Cabinet-level group,* for the purpose of examining various possible "incentives and disincentives to foster resource conservation." [145] The committee selected for study 10 existing or possible federal policies that could affect waste generation and recovery. The findings and recommendations of the committee, presented in its July 1979 final report, *Choices for Conservation,*[146] are discussed in the following section.

ECONOMIC INCENTIVES FOR WASTE REDUCTION AND RECYCLING

Beverage Container Deposits

Given the national interest in and political prominence of the issue, the Resource Conservation Committee gave special consideration to a mandatory national system of deposits and refunds for beverage containers. Deposits would reduce waste by encouraging recycling of bottles and cans.

Staff studies summarized in the committee's final report [147] indicated that such legislation would:

- Reduce litter volume by 35 percent eliminating 15 to 20 percent of the number of individual litter items;
- Reduce the amount of solid waste by up to 2 million tons per year, or 0.5 to 1.5 percent;
- Realize an annual savings in lower disposal costs of $25 to $50 million annually;
- Save 250,000 to 380,000 tons of aluminum (5 to 10 percent of annual production), reducing bauxite imports by a potential 1.6 million tons;
- Reduce steel consumption by about 1.5 million tons (1 to 2 percent of annual production);
- Reduce total atmospheric emissions caused by bottle and can production by 0.75 billion to 1.2 billion pounds;
- Reduce waterborne wastes from container production by 140 to 210 million pounds;
- Save 70 to 130 trillion Btus, equivalent to 33,000 to 61,000 barrels of oil per day, or 0.1 percent of total national energy consumption;
- Reduce the retail price of beverages an average of 0.5 to 1.5 cents per container, saving consumers a total of $0.66 billion to $1.76 billion annually:

*The members of the Committee were: Douglas Costle, Administrator, EPA, Chairman; Juanita Kreps, Secretary of Commerce; Cecil D. Andrus, Secretary of the Interior; F. Ray Marshall, Secretary of Labor; W. Michael Blumenthal, Secretary of Treasury; Charles Warren, Chairman, Council on Environmental Quality; Eliot Cutler, Office of Management and Budget; Lawrence J. White, Council of Economic Advisors; Alvin Alm, Department of Energy.

- Cause an unquantifiable amount of inconvenience to beverage consumers who presently purchase beverages in nonrefillable containers and discard the containers when empty;
- Eliminate between 4,900 and 10,400 jobs in the glass container production industry and between 14,200 and 22,000 jobs in the metal can production industry over a 5-year period; and
- Create between 80,000 and 100,000 new jobs in the beverage distribution and retail sectors.

In the committee's final report, four of the nine agency and department heads who were members of the Resource Conservation Committee recommended national beverage container legislation. Two officials wanted to wait to see the effect of such laws in the states—Maine, Michigan, Connecticut, Iowa, and Delaware—that have recently adopted them, before taking a position. (Only Oregon and Vermont have had beverage container deposit laws for several years.) One member of the committee took no position, and two were opposed.

The committee also recommended that if beverage container legislation were adopted, it should apply to all sealed beer and soft drink containers, regardless of material used, except cartons and carriers; that the deposit should be for a minimum of 5 cents, with possible increases scaled to the Consumer Price Index; and that the deposit should begin at the distribution-wholesaler level.

Other Deposit Systems

A waste management concept similar to beverage container deposits is that of a system of deposits or bounties for durable or hazardous goods. Under this arrangement, a consumer would pay a deposit when buying a refrigerator or auto battery, for example, which would be returned when the item was turned in at a disposal depot. The system would be valuable in encouraging proper disposal of hazardous substances, such as the chemicals in the car battery. However, its impact on total volume of municipal solid waste would probably be limited, because these items would still have to be disposed of. The Resource Conservation Committee decided that it did not have sufficient information to evaluate this concept and recommended further research.[148]

National Litter Tax

A concept that is often put forth as an alternative to beverage container and other deposit systems is that of a litter tax, that is, a special tax on frequently littered items such as beer cans. Such a tax could be earmarked to clean up litter and might provide an incentive against littering. The committee unanimously recommended against such legislation at the national level, however, for a number of reasons. First, such a tax would penalize those who do not litter as well as those who do. Second, to act as an incentive against littering, it would have to discourage buying the product altogether. To do

The Resource Conservation Committee rejected the concept of a litter tax on the grounds that it would create no incentives for individuals to clean up or reduce wastes. By contrast, beverage container deposits would do both. Photographer: Tom Raymond.

this would require an extremely large tax, perhaps 20 to 40 percent of the sales price. Such a structuring was considered both infeasible and undesirable. Lastly, the tax would create no incentive for individuals to clean up or reduce wastes. By contrast, beverage container deposits would do both.[149]

Solid Waste Disposal Charge

Congress specifically asked the Resource Conservation Committee to investigate and issue a report on the concept of levying solid waste management charges on consumer products; that is, a federal weight or unit-based tax on products and packaging that would be charged to the producer of the item and would be tied to the cost of disposing of the item. To take a hypothetical example, the manufacturer

of a pair of shoes might be charged 2 cents per pair, reflecting the cost of disposing of those shoes and the shoebox in which they are sold in a municipal landfill. Revenues from the tax would be distributed to local governments. Recycled materials used in products would be exempt from the tax.

The aim of this scheme is to create a financial incentive for manufacturers to avoid excess packaging and use recycled materials, and for consumers to do likewise, assuming that the tax will be passed along. However, the committee found less merit in this concept than in several others. No committee members voted to recommend a national disposal charge, largely because the effects of such a tax are simply too difficult to predict. The committee members were not convinced that the size of the incentives would be sufficient in practice to discourage excess packaging or to encourage use of recyclables. Yet such a tax would raise shelf prices of consumer goods.[150]

Local User Fee

The committee was more interested in a slightly different concept with a similar goal—the "local user fee"—but felt it lacked sufficient information to fully endorse the concept. Under this system, a municipality charges a household for waste pickup according to volume or weight of trash collected, i.e., by the bag, rather than financing garbage collection out of general or property tax revenues. The more waste, the higher the fee. Such systems are already used by some private waste collectors. In theory at least, it should be possible to set the fees so that consumers have an incentive to choose less wasteful products. It should also encourage households to recycle newspapers, bottles, and cans and to compost, thus reducing waste. However, it might encourage households to engage in illegal or "midnight" dumping of wastes in undesirable locations.

The committee acknowledged that little empirical data exist on how such fees actually affect householders' habits and stated that "the present state of knowledge makes it premature to create positive incentives for local governments to adopt user fees." It suggested further research and proposed that, in the meantime, the federal government should provide information to local governments on this technique.[151]

Product Design Regulations

Another potential method of reducing wastes and encouraging recycling is through direct intervention in the design of products. The government could require manufacturers to use more durable or simply fewer materials in the products they produce, or recycled or easily recyclable raw materials. The federal government could, for example, require that all newsprint contain a certain minimum percentage of recycled fibers. Or it could ban products like bimetallic (part aluminum, part steel, part other metals) cans that are difficult to recycle and interfere with the efficient operation of source separation programs.

The Resource Recovery Committee rejected the notion of direct regulation, because its impact is unpredictable and because it would be immensely difficult to administer and enforce. A newsprint rule, for example, might simply result in the diversion of recycled paper from some other use, like production of cellulose insulation, rather than actually causing a net increase in paper recycling. Detailed definitions as to what exactly is or is not recycled, would be necessary: for example, whether to count newsprint wastes produced at the paper mill or printing shops, as well as newsprint actually purchased and used by readers of the nation's dailies.

The committee did recommend further study, however, of potential regulation of materials that cause special hazards in disposal and those that significantly impede resource recovery operations (like bimetallic cans).[152]

Tax Policies

The Resource Recovery Committee also considered whether certain government policies might be hindering recycling. In particular, it considered whether recycled raw materials are at a competitive disadvantage, either because certain tax subsidies for virgin materials are not offered for recycled materials, or because freight rates are set at levels that discriminate against recycled materials in favor of virgin ones.

The committee's staff analysis confirmed the existence of a number of special tax advantages for virgin resource development. These policies were originally instituted on the grounds that stimulating resource development would contribute to economic growth and make the nation more self-sufficient. They include percentage depletion allowances for certain minerals and treatment of annual royalty income from iron ore and coal mining and income from sales as capital gains. These and several other provisions of the tax code are considered subsidies in that they depart from normal methods of taxing business income, to the industry's benefit. According to the committee's analysis, these subsidies amount yearly to $375 million for nonfuel minerals production and $275 million to $550 million for timber growing.[153] The committee stopped short of recommending abolition of the subsidies, however, recommending instead further study by other government entities considering tax reform.

Freight Rate Discrimination

The Institute of Scrap Iron and Steel and many others have long maintained that the rail freight rates established by the Interstate Commerce Commission (ICC) discriminate in favor of virgin raw materials at the expense of recycled materials. National policy on this issue was firmly enunciated in 1976, when Congress included a provision in the Railroad Revitalization and Regulatory Reform Act requiring the ICC to investigate its current rate structure and revise any rates found to be discriminatory.[154]

The Interstate Commerce Commission lowered freight rates for recycled paper and several other materials in certain parts of the country in 1979, after 2 years of investigation over whether its rates discriminated against recycled commodities.

In 1977, the ICC, using certain narrow definitions of the term, affirmed that its rate structure did not "discriminate" against recycled materials.[155] The ruling was appealed by two secondary material industry trade associations, the Departments of Energy and Justice, and EPA. In August 1978, the U.S. Court of Appeals for the District of Columbia ordered the ICC to examine its rates again using a broader definition of discrimination.[156] The ICC reopened its investigation and in April 1979 announced that it had found that, in fact, several commodities did suffer rate discrimination relative to competing virgin materials. It ordered secondary material rates to be reduced on scrap iron and steel in the South and West, on aluminum scrap in the East and South, on copper scrap in the West,

on lead and zinc scrap in the South, and on waste paper in the West and South.[157]

At the same time that the ICC was conducting its latest investigation, the Resource Conservation Committee staff made its own analysis of ICC data. It also concluded that freight rates discriminate against important secondary materials, but felt that the most serious discrimination was against waste paper and glass. It calculated that rate reductions of 38 percent for waste paper, 34 percent for glass, 1 to 29 percent for iron scrap, and 9 percent for waste aluminum might be in order.[158] Most of the committee members concurred in a recommendation that the Administration file a brief with the ICC presenting their findings and expressing its interest in achieving compliance with the Railroad Revitalization and Reform Act of 1976.

MATERIALS RECYCLING

Whatever the success of any economc incentives in reducing wastes, large amounts of waste will continue to be discarded. Municipalities will still face the same choices in dealing with their wastes: landfilling, incineration, materials recovery, and/or energy recovery.

EPA has taken certain direct steps toward stimulating materials recovery, with mixed success. It has issued guidelines for institution of beverage container deposits at federal facilities and is developing guidelines to increase federal purchasing of recycled products.

Beverage Container Deposits at Federal Facilities

Under authority granted it by the Resource Recovery Act of 1970, EPA issued guidelines in 1976 requiring a refundable 5-cent deposit on all beer and soft drink containers sold at federal facilities, except in cases where costs would be excessive.[159]

Federal agencies have been slow to implement these guidelines, despite a recent Executive order (October 1978) spelling out the responsibility of federal facilities to comply with federal environmental laws.[160] As of March 1979, only 14 of 52 agencies reported that they were implementing the guidelines agencywide.[161] More than half reported that their facilities were under the jurisdiction of the General Services Administration (GSA), which as of May 1979 had decided not to implement the guidelines on a broad scale. GSA made this decision on the basis of test projects at 12 sites which, it reported, had difficulty finding markets for collected containers and caused inconvenience to vendors.[162]

The Department of Defense also conducted a test of the guidelines at 10 military bases for a 1-year period ending June 1978. One of its findings was that where it was convenient, post residents would attempt to evade the deposits by buying beer and soft drinks off the post, causing a decline in beverage sales of 13 to 56 percent at the 10 installations. On the basis of that result, the Department of Defense declined to implement beverage container deposits at any of its installations. Nevertheless, the actual return rates for the con-

tainers purchased were quite good, ranging between 68 and 93 percent at the 10 bases.[163]

Federal Procurement of Recycled Materials

As noted earlier, municipal recycling efforts currently suffer greatly from the instability and inadequacy of industrial demand for recycled materials. One way the government could increase that demand would be for the government itself to buy products made from recycled materials. Such a policy would have many benefits beyond simply furthering municipal recycling programs: conserving natural resources; reducing dependence on foreign raw material supplies; reducing pollution; and conserving energy.

The Resource Conservation and Recovery Act required EPA to set guidelines for federal agencies "to procure items composed of the highest percentage of recovered materials practicable."[164] Although the agencies were supposed to be carrying out this policy by October 1978, EPA had issued no guidelines by that date. The agency is scheduled to propose its first guidelines in this area—regarding use of fly ash in concrete and cement—in February 1980.

EPA attributes some of its slowness in issuing these guidelines to the fact that it was initially faced with 45,000 different federal product and material specifications to review and evaluate. The agency has now decided to concentrate on a few products where use of recycled materials could be significant. EPA is due to issue additional guidelines—for federal purchase of recycled paper and of parkland soil conditioner that incorporates sewage sludge—later in 1980. Guidelines for procurement of construction products that use recycled paper, of glass, and of rubber are scheduled to be proposed in 1981.[165] EPA points out that even if procuring agencies were ready to comply, industries producing recycled products would not yet be prepared to supply all the products the government needs.[166]

ENERGY RECOVERY PROGRAMS

As explained above, a number of technical, institutional, and economic obstacles inhibit increased energy recovery through centralized waste processing facilities.

Research and Development

Both EPA and DOE have research and development programs whose goal is to overcome technical barriers to waste processing. EPA's program, begun by the Bureau of Solid Waste Management at the U.S. Department of Health, Education, and Welfare (HEW), dates back to 1967. Since EPA's creation in 1970, the agency has spent about $5 million a year on trash-to-energy technology and has sponsored six major demonstration plants.[167] EPA's involvement in the field, budgeted at $4.25 million for fiscal year 1978 and $2.5 million for fiscal year 1979 and scheduled to go lower in 1980, is now decreasing.[168] For the future, EPA expects to limit itself to assessments of environmental impact of trash-burning facilities and devel-

opment of better air pollution control methods. DOE's program began in 1976 under its predecessor agency, the Energy Research and Development Administration. It is funding demonstrations of less-developed trash conversion technologies, mainly pyrolysis and anaerobic digestion. DOE's expenditures were about $11 million in this field in fiscal year 1978 and are budgeted at $8.5 million for fiscal year 1979.[169]

In a February 1979 report examining the federal waste-to-energy program, the General Accounting Office charged the program with being "fragmented, uncoordinated, inadequately funded, uncertain in its priorities, and lacking in detailed overall strategy." [170] GAO believed that DOE and EPA were failing to coordinate their programs adequately, despite an interagency agreement worked out in 1976 to do so. It pointed out, for example, that research and development contracts were not being reviewed for possible duplication.[171]

It is especially vital that adequate lines of communication between the two agencies be established and used in the coming year. Such communication is necessary to insure that, as EPA phases out its involvement in technology development, DOE takes advantage of the experience and lessons that EPA has gained. DOE currently sponsors a number of projects in pyrolysis. This technology has the potential for helping to supplement the nation's oil supplies; however, EPA has found that technically it is very difficult to make pyrolysis projects work. It is also important that DOE adequately pursue technologies that EPA found promising. EPA feels that development of "briquets" of refuse-derived fuel, for example, could be an extremely fruitful avenue of research.[172]

Planning Assistance

As discussed earlier, too often the barriers to building and operating a waste processing facility are not so much technological as institutional. In the past, EPA provided some assistance to communities in how to go about the complex task of planning and organizing such a facility, with panels consisting of EPA staff members, outside consultants, and state and local officials with expertise in engineering, finance, and management. Between January and October 1978, 245 requests for assistance had been filled under this program.[173] The budget for the panels program was $3.75 million in fiscal year 1978 and is expected to be about $4.5 million in fiscal year 1979.[174] However, EPA has indicated that, for the future, the panels will increasingly be used to deal with hazardous wastes and solid waste problems other than resource recovery.[175]

In 1979, Congress allocated $15 million under President Carter's urban program to assist cities in initiating resource recovery projects. Grants can be used for investigating markets, assessing technologies, doing feasibility studies, analyzing local issues, and negotiating contracts. EPA selected 68 communities to receive awards under this program in 1979. It hopes to continue the program for 2 more years.[176]

EPA plans to issue guidelines for federal purchase of recycled rubber in 1981. Meanwhile, tires continue to accumulate in dumps and landfills across the country. Less than 4 percent of the rubber disgarded in municipal waste was recycled in 1977.

DOE also has a technical assistance program that provided $2 million in planning grants in fiscal year 1978.[177]

Finally, some of the funds EPA is providing to states for the overall planning of their waste management strategies under RCRA may be used for planning of resource recovery. These funds totaled $14.2 billion in fiscal year 1978 and are budgeted for $15.2 million in fiscal year 1979.[178]

Capital Cost Assistance

A waste processing facility capable of handling 1,000 tons of refuse a day can cost $25 million to $50 million to plan and build. Coming up with such a large sum is not easy, especially when, because of the newness of the field, many financial institutions regard such plants as high-risk ventures.[179]

Government can assist communities in this area through loan guarantees, tax exemptions for municipal industrial development or pollution control bonds, other tax benefits for facilities, or outright construction grants. To date, many of the larger waste processing facilities have, in fact, been financed by issuance of tax-exempt municipal bonds.[180]

Another tax benefit now available to builders of waste processing plants is an investment tax credit. The Energy Tax Act of 1978 allows businesses to take an additional 10 percent investment tax credit for installing alternative energy systems, including recycling equipment.[181] According to DOE, such credits are expected to reduce the cost of producing energy from municipal solid waste by 5 to 19 percent.[182]

A third possible form of federal aid is loan guarantees. Although the Energy Conservation and Production Act of 1976 [183] authorized such guarantees up to $2 billion, none has been made. GAO has criticized DOE for failing to request any appropriations under this program, which expires at the end of fiscal year 1979. The DOE Energy Act of 1978 also authorized certain kinds of loan guarantees, although the Congress declined to appropriate money for this purpose for fiscal year 1979.[184]

OUTLOOK FOR THE FUTURE

Municipalities facing high disposal costs or the lack of an environmentally acceptable landfill site may want to institute a source separation program or build a centralized waste processing facility, or both. Each system has advantages and disadvantages that may suit it for one area and not another (see Table 4–12).

Instituting a program of household separation and recycling of wastes will cost a city a certain amount (up to $7 per ton of waste processed, exclusive of collection costs). However, it will probably cost less than building and operating a centralized facility ($3 to $15 per ton) and almost certainly less than building and operating

Table 4–12

Comparison of Source Separation and Centralized Waste Processing as Methods of Municipal Waste Disposal

	Source Separation	Centralized Waste Processing
Typical size of processing facility	10 tpd	1000 tpd
Typical capital investment (dollars)	low (50,000)	high (25,000,000)
Net cost per ton processed (after revenues)	$0–7	$3–15
Reduction in waste stream (percent)	10 to 50	75 and up
Products recovered	glass, paper, iron, aluminum	energy, iron
Environmental impact	negligible	some air pollution and worker health hazards

tpd=tons per day

an incinerator ($25 to $35 per ton).[185] Source separation can be instituted in a city of any size. However, the fact that public cooperation is essential means that source separation may be begun more easily in small towns and rural areas, where citizens can be closely involved in the decisionmaking process.

There are two basic disadvantages of source separation relative to centralized waste processing. First, source separation generally reduces wastes by 10 to 50 percent (by weight), compared with 75 percent or more at a centralized facility. Second, separation yields materials, which may be most useful to a more-or-less distant industry, rather than energy, which is useful locally. However, although a centralized waste processing facility can help meet a locality's energy needs, it requires a large initial investment. It is also a relatively costly disposal method, may cause air pollution problems, and may not produce energy in an optimally useful form. The best markets for energy-from-trash seem to be industrial facilities or district heating systems that can make use of steam. Because the economics of centralized waste-processing plants usually dictates a capacity of at least several hundred tons per day, such facilities appear best suited to urban areas where wastes from 100,000 or more people are available. However, some smaller towns are experimenting successfully with small modular units.

A number of cities are already experimenting with both kinds of systems. A modest, step-by-step approach seems to be working best in most places. The relatively elaborate source separation program considered in 1976 by the city of Northglenn, Colo., never got off the ground. City officials found they were simply too busy dealing with other problems, including construction of a $31 million sewage treatment plant, to get a new $200,000 waste system involving anaerobic digesters and earthworm colonies underway at the same time.[186]

The city elected instead to institute a limited source separation effort in 1977, involving separate collection of newspapers, which are sold, and grass clippings, which are composted on city land. The city still hopes to institute the more advanced program eventually, recycling and selling bottles and cans, and using bacteria and earthworms to process grass, other organic wastes, newspapers, and manure from a local dairy into useful soil.[187]

A plan for a very large trash-to-energy plant, which Union Electric of St. Louis first proposed in 1976, also ran into difficulties and delays. First, because of the great quantities of waste involved (had it been built, the facility would have been four times larger than any plant operating today), the plant required four transfer stations at different locations. The planners were able to acquire the sites for three of them, but local residents vehemently protested the fourth. Shortly thereafter, a state referendum denied all utilities the right to pass interest costs involved in building new plants along to their customers until the projects are actually producing electricity. In 1977, Union Electric announced that it would not go forward with the St. Louis project, and a much more modest venture is now planned.[188] The Bi-state Development Agency—an independent authority that runs the local bus system—is considering a 1,000-ton-per-day facility, which will supply steam to a local industry, rather than the originally planned 8,000-ton-per-day plant.[189]

The experience of these cities points up the need to proceed incrementally in projects of this type. Other lessons also may be drawn as well. The prerequisites for success of a source separation program seem to be:

- Obtaining long-term contracts that dictate floor prices for purchase of recyclable materials;
- Having those whose cooperation is essential to the project, i.e., householders and refuse collectors, solidly behind the project before initiating it; and
- Integrating the source separation program fully into the regular town waste disposal system with household separation mandated by ordinance.

The prerequisites for success of a centralized waste processing facility appear to be:

- Using one of the simpler, proven technologies;
- Locating a user for the energy produced; and
- Designing a facility to process only a portion of the jurisdiction's waste.

The latter measure not only avoids waste shortfalls, but leaves the door open to instituting complementary waste reduction or source separation schemes.

GAO has pointed out that the speed with which we expand our resource recovery efforts over the next 5 to 10 years depends upon a number of factors including the ability of cities to work out institu-

tional problems, the degree to which industry will provide markets for recovered energy and materials, and the degree to which cities can solve capital and financing problems. Cities may have a strong incentive to solve these problems, however, as it becomes increasingly difficult to find land that is sufficiently remote and undesirable and that the public is willing to let be allocated to waste disposal; and as it becomes increasingly expensive to discard the wastes in an environmentally sound fashion. The cost of sanitary landfilling, last estimated at $1 to $20 per ton, is expected to rise by $3 to $12 a ton, depending on the size of the site, environmental factors, and previous practice, as new federal and state standards go into effect.[190] At these higher rates, source separation and resource recovery will undoubtedly become a competitive disposal option in many more cities. EPA's $15 million planning grant program under President Carter's urban assistance program may aid a number of cities in taking new initiatives to recover valuable resources from city waste.

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CHAPTER 5

ENERGY

The U.S. energy dilemma was painfully apparent in the summer of 1979. The long lines and short tempers at gasoline stations were clear evidence of the nation's continuing vulnerability to interruptions of oil supply through events beyond its control.

The nation's century-long predominance as the world's greatest producer of oil is over. U.S. oil production peaked in 1970, but our appetite for oil has continued to grow. We still consume about 30 percent of the world's yearly oil production. Yet our habits and our enormous investments in sprawling suburbs, high-speed highways, and an interrelated system of homes, jobs, commerce, and industry dependent on cars and trucks make it difficult to moderate demands for oil quickly and flexibly, even in the face of shortages or galloping price increases.

One response to the dilemma is to get more energy from the domestic sources still available to us. Another is to make the supplies we have go farther and last longer through greater energy productivity—in other words, long-term conservation of energy resources.

In his April 1979 address to the nation on the energy problem, President Carter observed that our national strength "is dangerously dependent on a thin line of tankers stretching halfway around the earth." He stressed the point that no single solution exists: "We must produce more. We must conserve more. And we must join together in a great national effort to use American technology to give us energy security in the years ahead."

In his energy address of July 15, 1979, the President set clear goals for increasing energy independence. "From now on," he said, "every new addition to our demand for energy will be met from our own production and our own conservation." Calling for "the most massive peacetime commitment of funds and resources in our nation's history to develop America's own alternative sources of fuel," the President also stressed his commitment to a bold conservation program. This effort, he said, will allow U.S. citizens to build conservation into their homes and lives at a cost they can afford.

The following discussion briefly describes actions that are being or can be taken to meet U.S. energy needs.

MEETING ENERGY NEEDS

From its early days, the Carter Administration has stressed greater energy productivity—conserving resources and getting more use out of every barrel of oil and ton of coal—combined with accelerated development of domestic energy sources, especially renewable, environmentally benign sources. Many of the measures proposed in the 1977 National Energy Plan and later adopted in the National Energy Act of 1978 reflect this approach.

A Council on Environmental Quality report, *The Good News About Energy,* published in February 1979, examined the possible contribution that increased energy productivity could make in meeting national energy, economic, and environmental goals. The report concluded: "The United States can do well, indeed prosper, on much less energy than has been commonly supposed." Basing its conclusions on a review of 44 recent studies, the Council estimated that gross national product could nearly double in the next 20 years, with an increase in energy consumption of no more than 25 percent—or perhaps, with a determined effort, 10 to 15 percent.

With more effective conservation, the benefits of energy—higher labor productivity, comfortable homes, mobility, and so on—can be enjoyed with a lesser expenditure of energy resources. Increasing energy productivity provides a badly needed flexibility: it reduces pressures to develop domestic energy sources that involve serious pollution problems or land and community disruption; it makes more capital available to invest in desirable social goals other than energy production; it provides more time to develop renewable energy sources.

The conservation possibilities described by the CEQ report do not depend on technological breakthroughs; many are available now or require no more than modest development efforts. However, the report recognized that the full potential for greater energy productivity is not likely to be realized without some important institutional changes. These could take the form of regulatory requirements or economic inducements. For example, the nation can adopt tough energy performance standards in building codes; it can also provide tax incentives for industries to encourage them to generate electricity together with their process steam. The changes could involve the removal of impediments to conservation; for example, by altering tax provisions that reward utilities for greater capital investment but not for energy efficiency, or by insuring that energy prices accurately reflect the cost of replacing present resources.

The federal government is working actively on a number of these institutional issues. The Department of Energy is completing federal performance standards that will establish energy-efficient requirements for new buildings. Working with the Congress, the President has supported a $6 billion program that would provide interest subsidies on loans to finance residential and commercial conservation measures and would eliminate the current prohibition on finac-

ing of conservation investments by utilities. Under the National Energy Act of 1978 price controls on new natural gas will be phased out by 1985. In his April 1979 energy message the President acted to phase out price controls on domestically produced crude oil by September 30, 1981 to encourage energy conservation and increased domestic production. Under the Public Utility Regulatory Policies Act of 1978, signed by the President in November 1978, state public utility commissioners are required to consider numerous criteria which can improve utility conservation practices and rate structures.

In the longer run, intensified research and development can make available still more efficient ways of using energy. At the same time, energy from the sun—safe, renewable, nonpolluting, job-producing—can provide an increasingly large share of our energy supply. In his June 1979 message to the Congress on solar energy, President Carter called for a "long-term commitment to a society based largely on renewable sources of energy." The solar strategy he outlined, based on a 13-month governmentwide review, is aimed at meeting 20 percent of the nation's energy needs in the year 2000 with solar and renewable sources.

Recognizing public concern over the safety of nuclear power plants following the Three Mile Island accident, the President appointed a commission to assess what happened and make recommendations. Meanwhile, the Administration continued to support a contribution from nuclear power plants to U.S. energy supply, emphasizing the development of greater efficiency in "conventional" light water reactors. The President again called for termination of the Clinch River

This solar house was built by an Exxon division in Foxboro, Mass. to study energy-efficient construction combined with a solar energy system. The builder used ordinary construction techniques and materials.

Breeder Reactor. He also asked for basic research into reactor designs that will help to maintain our uranium supply, but will not easily lend themselves to diversion of nuclear fuels for making weapons. After a year-long review, a federal interagency task force recommended to the President goals for managing nuclear wastes. The principal objective, the group concluded, was to insure that nuclear wastes are isolated from the biosphere and pose no significant threat to public health and safety.

In November 1978 the President signed into law the National Energy Act, which culminated 18 months of intense congressional and public debate over national energy policy. The Act comprises five separate pieces of legislation:

- The National Energy Conservation Policy Act, which established a variety of regulatory, grant, and loan programs to enhance conservation.
- The Energy Tax Act, which contains a range of tax credits for conservation and solar energy as well as other tax measures designed to reduce our dependence on imported oil.
- The Natural Gas Policy Act, which essentially decontrols the price of new natural gas and establishes other measures designed in part to encourage production of natural gas.
- The Public Utility Regulatory Policies Act, which provides methods for encouraging public utility rate structure revisions so as to move towards pricing of energy to reflect replacement costs.
- The Powerplant and Industrial Fuel Use Act, which is designed to increase the use of coal.

More detailed discussion of these acts follows in later sections of this chapter.

In his April 1979 Energy Message, the President acted to decontrol gradually over a two year period the price of oil and proposed a windfall profits tax to capture a portion of the profits that would otherwise be realized by oil compaies due to decontrol. The President also underscored in the message the broad array of energy conservation actions already underway.

In his July 1979 energy address, President Carter set a goal of cutting U.S. dependence on foreign oil by one half by 1990—a saving of 4.5 million barrels of imported oil per day. The program he proposed to meet the goal would:

- Create an Energy Security Corporation to direct the development of substitutes for 2.5 million barrels per day of oil by 1990—from a mix of coal liquids and gases, oil shale, biomass, and unconventional gas;
- Establish a three-member Energy Mobilization Board with the authority and responsibility to expedite permits for and construction of critical energy facilities;
- Provide new incentives for development of heavy oil resources, unconventional natural gas, and oil shale;

- Require utilities to cut current oil consumption by 50 percent, saving 750 thousand barrels of oil per day;
- Establish a major new residential and commercial conservation program;
- Provide $2.4 billion annually in assistance for energy needs to low-income families; and
- Provide a total of $16.5 billion over the coming decade for improvements in the nation's mass transportation system and in automobile fuel efficiency.

This program to increase domestic energy production, in combination with the solar and conservation measures announced earlier in the year, is expected to meet the President's goal of significantly reducing oil imports.

The President repeated his proposal of April 1979 for a windfall profits tax on oil, and pledged $140 billion of the windfall profits tax revenues over the next 10 years to fund the energy program.

The proposal to foster rapidly increasing production of synthetic fuels precipitated a serious national debate on the merits of the synthetic fuels program. Environmental organizations raised numerous concerns over the environmental effects of producing synthetic fuels from coal and oil shale. A discussion of environmental issues associated with the development of synthetic fuels is presented later in this chapter.

THE ENERGY TRANSITION— FROM FOSSIL FUELS TO RENEWABLE ENERGY SOURCES

A long-term perspective on energy supplies, to which many people are giving serious thought, requires an assessment of how to change over from one dominant form of energy supply to another. The nation's present economy and lifestyle are based on oil and gas for which no convenient, secure alternatives have been available as domestic supplies became scarce and costly. Although higher prices should encourage more exploration for domestic oil and gas and promote increased energy productivity, the prospect that the nation will ever again be self-sufficient in oil supplies is slim. In the long run, the United States must move away from oil and gas, which currently meet 75 percent of our needs, to new energy sources.

The only three known sources of energy to which we can turn are fossil fuels, including coal, oil shales, unconventional natural gas, and tar sands; nuclear energy, fission at present and perhaps fusion someday; and renewable energy in its broadest sense, meaning not only direct capture of solar energy, in home and hot water heating, but also in wind, falling water, biomass, and photovoltaics. For much of the world, these renewable energy sources may be the only completely indigenous ones.

The relative advantages and drawbacks of these generic energy sources are not altogether understood, but certain broad statements receive general agreement. Solid fossil fuels, although very abundant, tend to be environmentally damaging to mine, process, and burn, and all fossil fuels pose the long-term threat of possible adverse climate changes. Ultimately, fossil fuels will have to be replaced by other sources as they become depleted.

Nuclear energy in the form of breeders or fusion may be considered inexhaustible energy sources. Nuclear plants emit no air pollution and pose no threat of climate modification through buildup of carbon dioxide. Their principal unresolved problems are safety, weapons proliferation, waste storage for fission products, and as yet unproven scientific feasibility for fusion.

Solar energy has the dual advantages of being inexhaustible and environmentally benign. It poses no threat of increasing carbon dioxide concentrations in the atmosphere. Its main drawback is that in most forms it is intermittent, although ocean thermal conversion, biomass, and hydropower are possible exceptions. Moreover, some of solar energy's forms, for example, electric power from photovoltaics, are at present much more expensive than fossil or nuclear alternatives.

All of the three principal energy sources are likely to be more expensive than the cheap oil and gas of the past. What combination of these three sources should we plan to use over the next several decades? And for what forms should we emphasize development efforts? The drawbacks of fossil fuels—their immediate and longer-term environmental risks, the fact that they are ultimately exhaustible—suggest that their use should be transitional. If this reasoning is accepted, some believe that preferable forms for using fossil fuels during the transition period—which may cover the next few decades, or perhaps longer—would be those that most closely match the energy forms of the longer-term future. These are primarily electricity (from solar or nuclear) and low-grade heat from solar and geothermal and, to a lesser degree, wood and alcohol (from biological sources). Except for relatively small amounts of alcohol or methane derived from biological sources, some believe it very unlikely that carbon-based liquids or gases such as gasoline or natural gas will be in widespread use when solar and nuclear energy finally becomes our major sources of supply.

Several ideas emerge from the considerations outlined above. First, given that all new energy sources will be much more expensive than those of the past, the nation should make every effort to increase its energy productivity. High efficiency should be built into every sector of the economy. Second, active and passive solar heating and solar hot water systems should be encouraged in the construction of all new residential, commercial, and industrial buildings; it seems to be in the nature of these forms of solar energy that they will never be

cheaper or easier to incorporate into buildings than they are now. Third, the nation should begin a major effort to reduce its reliance on liquid fuels by developing and introducing alternative power systems—not based on petroleum—for transportation. The technical feasibility of both hydrogen and battery-powered vehicles has been demonstrated. Their widespread use would help insure compatibility with future electric energy sources. The use of hydrogen or batteries to store energy would also help deal with the intermittency problem posed by solar sources.

The above ideas seem valid on the basis of existing evidence, but it is clear that a great deal of systems research and analysis remains to be performed to better understand the options for guiding the transition to inexhaustible energy sources. The difficulty that we face today is planning our near-term energy future without fully understanding how it will relate to our mid- and long-term energy options.

Major initiatives in a number of areas related to the transition to longer term energy sources have already been implemented or proposed. The National Energy Act provides tax credits to homeowners to encourage residential conservation and use of solar technology. A part of the President's July 1979 energy program proposes the investment of $16.5 billion from the windfall profits tax to encourage mass transportation and more efficient automobiles. In his June 1979 Solar Message the President proposed a broad range of initiatives to encourage greater reliance on renewable energy sources. The Department of Energy has a $41 million research and development program on alternative power systems for ground transportation. These efforts are laying the foundation for a transition to renewable energy sources.

UNITED STATES ENERGY DEMAND

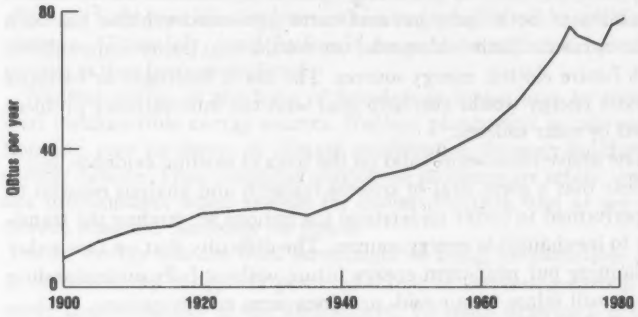
In 1978 U.S. demand for energy increased slightly over 1977. The change reflected fairly large increases in energy use in homes and commercial buildings and transportation, and a small increase in energy use by industry. With the passage of the National Energy Act of 1978 (NEA) [1] and its conservation provisions, U.S. demand should grow more slowly in the future than it otherwise would have. However, there are still many institutional and technical barriers to increased energy productivity that will have to be overcome if the nation is to use its energy resources as economically as it could.

1978 ENERGY DATA

U.S. energy consumption in 1978 totaled 78.2 quadrillion British thermal units (QBtus), topping the consumption of 76.5 QBtus recorded in 1977 (see Figure 5–1).

Figure 5–1

U.S. Gross Energy Consumption, 1900–78



Source: U.S. Department of Energy, Monthly Energy Review, DOE/EIA/6(79), June 1979.

After declining in 1974 and 1975, energy consumption has now increased for 3 consecutive years. The growth rate in gross energy consumption was 2.1 percent in 1978, down from the 1977 rate of 2.7 percent and the 1976 rate of 5.4 percent.[2]

The consumption growth rates of each energy source in 1978 and the share contributed by each to total energy consumption were as follows:

Energy Source	*Growth Rate*	*Share of Total Consumption*
• Petroleum:	+ 2.1 percent	49 percent
• Natural gas:	— 0.7 percent	25 percent
• Coal:	— 0.3 percent	18 percent
• Nuclear power:	+10.2 percent	4 percent
• Hydropower:	+24.9 percent	4 percent

The decline in coal use probably resulted from the coal miners' strike. Hydropower varies widely from year to year, depending on rainfall. The substantial increase in 1978 reflects the recovery from the 1977 drought in some major watersheds.

Total domestic energy production in 1978 rose to about the 1974 level. Production amounted to 61 QBtus in 1978, 1 percent above the figure for 1977 and 1.5 percent greater than the output in 1976. More details on domestic energy production over the past several years are provided in Table 5–1; further detailed energy data are shown in Appendix A, Environmental Statistics. For individual fuels, production growth rates for 1978 were:

- Crude oil: +5.5 percent
- Natural gas: −1.8 percent
- Coal: −5.3 percent

Table 5–1

Domestic Energy Production by Primary Energy Type

Year	Coal [a]	Crude Oil [b]	NGPL [c]	Natural Gas (dry)	Hydro-Electric Power [d]	Nuclear Electric Power	Other [e]	Total
				Quadrillion (10^{15}) Btu				
1973	14.366	19.493	2.569	22.187	2.859	0.910	0.046	62.431
1974	14.468	18.575	2.471	21.211	3.175	1.272	0.056	61.228
1975	15.189	17.729	2.374	19.641	3.152	1.900	0.072	60.057
1976	15.853	17.262	2.327	19.480	2.976	2.111	0.081	60.091
1977	15.964	17.454	2.327	19.565	2.337	2.702	0.082	60.431
1978	15.117	18.420	2.255	19.222	2.963	2.977	0.068	61.022

[a] Includes bituminous coal, lignite, and anthracite coal.
[b] Includes lease condensate.
[c] Natural gas plant liquids.
[d] Includes industrial and utility production of hydropower.
[e] Includes geothermal power and electricity produced from wood and waste.

Source: U.S. Department of Energy, Energy Information Administration.

The principal reason for the rise in domestic crude oil production was Alaskan oil. Although production in the lower 48 states continued to decline (down 4 percent from 1977), the crude oil coming through the Trans Alaska Pipeline from the North Slope more than made up the difference. This increase is believed to be transitory, however. With the continued decline of old oil fields, U.S. oil production, even with Alaskan oil, may turn down again in the 1980s.

Energy imports dropped in 1978 with the rise in U.S. oil production, but they continued to play an essential role in filling the gap between domestic production and demand. A total of 18.9 QBtus was imported in 1978, a decrease of 6 percent from the 1977 total. Net petroleum imports (crude oil and products) declined 8.1 percent, and imports of natural gas dropped by 4.8 percent.

Energy consumption by sector repeated recent trends, with the industrial sector continuing to show evidence of increased energy efficiency. Sectoral growth rates for 1978 were:

- Residential/Commercial: +3.5 percent
- Transportation: +2.7 percent
- Industrial: +0.3 percent

An indication of increasing energy efficiency in industry is a continuing decline in the energy required per unit of national output. In 1978 the energy/gross national product (GNP) ratio declined 2 percent, to reach about 56,400 Btus per dollar of GNP (1972 dollars). By comparison, the ratio was about 61,200 Btus per dollar in 1972.

AUTOMOBILE FUEL ECONOMY TRENDS

A far-reaching provision of the Energy Policy and Conservation Act of 1975 [3] was its mandatory fuel economy standards for automobiles. Under the law, the average fuel economy for each manu-

Figure 5–2

Automobile Fuel Economy and Standards, 1967–85

[a] Based on 1975 Federal Test Procedure (FTP) city/highway-weighted. For the 1975–1978 model years, the new car fuel economy is sales-weighted by manufacturers' sales forecast data. For earlier model years, production data were utilized.

[b] Sales-weighted FTP value adjusted to on-road fuel economy values.

[c] As calculated by the FHWA.

Sources: J. D. Murrel, *Light Duty Automotive Fuel Economy . . . Trends Through 1978*, SAE Paper 780036, 1978; U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics*, annual; U.S. Department of Transportation, National Highway Traffic Safety Administration, *Automotive Fuel Economy Program, Second Annual Report to Congress*, Washington, D.C., January 1978.

facturer's entire fleet of new cars for the year had to be 18 miles per gallon (mpg) by 1978, and 27.5 mpg by 1985. The auto industry has made notable progress in achieving these requirements. Figure 5–2 illustrates the improvements that are beginning to show up in new car gasoline mileage. Average new car sales-weighted fuel economy, as determined by EPA's Federal Test Procedure, has risen steadily from a low of 14.4 mpg in 1974 to 19.6 mpg in 1978.[4]

However, these improvements have not been fully realized in performance on the road. Estimates of actual on-road fuel economy of new automobiles, prepared for DOE, show an increasing divergence from assembly line new car tests, as measured by the EPA's Federal Test Procedures (FTP), between 1974 and 1977. The on-the-road

tests indicate a considerably smaller improvement than do EPA's FTP figures. And from 1976 to 1977 on-the-road tests showed an actual decline in average fuel economy, from 16 to 15.7 mpg. [5]

The difference between the EPA assembly line test and on-road fuel economy results from three general kinds of problems: first, test results on the road may be inherently different from those of a dynamometer test in the laboratory; second, operating conditions in actual use may be different from the simulated conditions in the EPA tests; and finally, the prototype vehicles used for EPA certification may differ from the typical production model reaching the road.

Problems in all three categories contribute varying amounts to the differences in test results, depending on model year, manufacturer, and vehicle design. It appears that the first two categories contribute about one-half to two-thirds of the gap, while the last is responsible for one-third to one-half of the difference.[6] Table 5–2 provides a representative list of specific problem areas and a rough estimate of their fuel economy impacts. Many of these problems may be reduced through adjustments in EPA procedures.

Table 5–3 provides more details on how the indicators of fuel economy have changed over time. The difference between EPA sales-weighted mpg ratings and actual on-road tests has increased from 0.5 mpg in the 1974 model year to 3.5 mpg in 1977.[7] For cars with a 20 mpg on-road fuel economy, the differences are greater—6 mpg in 1977. The data suggest that assembly line tests showing compliance with 27.5 mpg in 1985 might, in fact, reflect actual on-road fuel economy of about 20 to 24 mpg.[8] With existing test procedures, it appears that a substantial portion of the expected savings in 1985 highway fuel consumption might not actually be achieved.

Table 5–2

Some Problem Areas Associated with EPA's Federal Test Procedure and Their Fuel Economy Impacts

Description of Types of Problems:
Type A—Dynamometer-to-road shortfall
Type B—EPA test-to-in-use shortfall
Type C—Prototype-to-production shortfall

Problem	Fuel Economy Impact (percent)
Tire slip on dynos	Type A—0–5
Exhaust system leaks	Type A—0–3
Accumulated mileage on in-use cars	Type A/C 0–4
Representatives of lubricants for certification vehicles as compared to in-use practice	Type C—2–5
Tire inflation pressure differences	Type C—2–4
Production replacement tires differ from certification tires	Type C—0–20 depending on tire type
Certification vehicle build practices	Type C—5–10
Temperature effects	Type B—large depending on temperature
Accessory load simulation differences	Type B—0–10

Source: U.S. Department of Energy/U.S. Environmental Protection Agency, *Fuel Economy Measurement Problems—Changes and Resources* (1978).

Table 5–3

EPA Certification vs. Actual On-Road Fuel Economy Model, 1974–77

	1974	1975	1976	1977
Mean EPA certification mpg	14.0	15.5	18.6	19.5
Mean on-road mpg	13.4	14.1	16.0	15.7
Difference for car with EPA sales-weighted mpg	0.5	1.3	2.3	3.5
Difference for car with 20-mpg on-road economy	4.0	2.7	3.9	6.2

Source: B.D. McNutt, D. Pirkey, R. Dulla, C. Miller, *A Comparison of Fuel Economy Results from EPA Tests and Actual In-Use Experience, 1974–1977 Model Year Cars*, prepared for U.S. Department of Energy, Office of Conservation and Advanced Energy Systems Policy, Contract No. EC-76-C-01-8435 (February 1978).

NEA CONSERVATION PROVISIONS

Several provisions of the National Energy Act of 1978 are expected to produce more efficient and productive use of energy and thereby reduce energy demand. One of the five laws that constitute the NEA directly relates to this goal. Provisions in several of the other laws affect energy productivity significantly though less directly.

The National Energy Conservation Policy Act of 1978 includes the following measures:

- Utility conservation programs for residences—Utilities are required to offer residential customers energy audits that identify appropriate energy conservation and solar measures, and estimate their expected costs and savings; utilities must offer to arrange for the installation and financing of such measures;
- Weatherization grants—The U.S. Department of Energy's (DOE) weatherization grants program for insulating homes of lower income householders is extended through 1980 at an annual authorized level of $200 million;
- Grant program for public buildings—Grants to states totaling $900 million are authorized to assist schools and hospitals, fund energy audits, and install energy conservation and solar measures. Additional funds are provided to conduct energy audits of local public buildings and public care institutions;
- Appliance efficiency standards—DOE is required to set energy efficiency standards for a wide range of appliances; and
- Energy conservation in federal buildings—All existing federal buildings of sufficient size are required to undergo an energy audit. By 1990, all federal buildings are required to be fully retrofitted with energy conservation measures that improve their energy efficiency in general and minimize their lifecycle energy costs; all new buildings must be designed to minimize their lifecycle energy costs.

Other parts of NEA also have major implications for fuel conservation. The Natural Gas Policy Act significantly increased the price of new natural gas, provides for additional phased price increases through 1985, lifts price controls on new gas and certain intrastate natural gas as of January 1, 1985, and deregulates within one year very

high cost gas from special sources such as geopressurized brine, Devonian shale, and wells below 15,000 feet. These measures phasing out federal controls on natural gas prices mean that the price of gas will be closer to actual replacement value, and will provide signals to consumers to conserve and stimulate production as well. The Public Utility Regulatory Policies Act encourages cogeneration of steam and electricity by industry, requires utilities to buy the electricity at reasonable prices, and requires state regulators and utilities to consider rate design standards that encourage conservation. Finally the Energy Tax Act provides residential tax credits for insulation and conservation of up to $300 and business tax credits for investments in conservation. The Act also imposes a graduated tax on gas guzzling cars, beginning with the 1980 model year and increasing each year until 1985, at which time the maximum tax on the most inefficient car would be $3,850.

In his April 1979 Energy Message to the nation, President Carter noted the following efforts which were underway for long-term conservation, or better energy productivity:[9]

- Phase out of subsidized parking for federal employees;
- Establishment of energy performance standards for buildings;
- Rapid implementation by utilities of residential conservation service activities;
- Formation of an Energy Coordinating Committee Task Force on Increasing National Energy Productivity; and
- Development of a workshop for state public utilities and others to explore conservation opportunities.

The July 1979 programs outlined earlier in this chapter build on the programs described above.

POTENTIAL FOR CONSERVATION

Several new reports on the potential for energy conservation were published in the last year, including a report by CEQ in February 1979 and the report of the Energy Project at the Harvard Business School in mid-1979. The following were conclusions of the CEQ report, *The Good News About Energy*.[10]

First, if the nation makes a serious effort to increase energy productivity, it is possible to have a vigorous economy in the coming decade with energy growth far below that predicted only a few years ago. With a moderate effort to increase energy productivity, our year 2000 energy consumption need not exceed current use by more than about 25 percent. With a more determined effort, energy consumption need not increase by more than about 10 to 15 percent. At the same time, total real GNP could increase sharply to nearly double today's level. Even with assumptions that may be overly pessimistic, computer simulations by the Harvard Institute of Economic Research suggest that each percentage point reduction in year 2000 energy

demand generally results in a decrease in GNP of no more than 0.2 percent.[11]

Second, technology is now available to increase U.S. energy productivity in an economical manner. More efficient buildings can save the homeowner several dollars for every dollar judiciously invested in energy-conserving features. By selecting vehicles with more efficient designs, automobile users can economically reduce fuel costs by 50 percent or more. A wide variety of conservation technologies available to industry today can often provide a 30 to 50 percent per year return on investment.

Third, the feasibility of a low energy growth future means that several very serious environmental and economic problems can be largely avoided:

- By greatly reducing the number of new coal and nuclear power plants needed to meet the growth in electrical demand, the nation can dramatically limit the associated pollution, radiation hazards, and land disruption;
- Our dependence on foreign fuels can be substantially cut from what it otherwise would have been;
- By emphasizing conservation rather than supply technologies which are more costly, capital can be made available for other socially useful and job-producing investments; and
- More time will be available for the widespread application of renewable energy technologies.

The report concluded with a brief review of the additional steps that have been recommended by a number of authorities to increase energy productivity. These include:

- Price energy more accurately to reflect the cost of replacing our existing resources;
- Improve existing conservation programs by: setting building energy performance standards that can only be met by using the full range of cost-effective technology; expanding investment tax credits to include cogeneration equipment; raising post-1985 automobile fuel economy standards above 27.5 mpg; and expanding design/performance awards to encourage energy efficiency improvements;
- Remove institutional barriers that discourage conservation; modify provisions of the Internal Revenue Code that bias utilities toward capital intensity and away from conservation; support land use planning to increase the energy efficiency of transportation systems; expand efforts to provide more information to state and local governments and the public on the benefits of fuel conservation; develop incentives to encourage more riders per car, thus improving load factors, and incentives to transportation alternatives that are more energy-efficient than private automobiles;
- Improve federal conservation research and development programs; and

- Encourage citizens to make conservation a more important consideration in their everyday activities and decisions.

A number of efforts are underway that address these issues. As noted above, oil and natural gas prices are gradually being decontrolled, and energy performance standards are being completed by the Department of Energy that will reduce energy use in new buildings. Under the Energy Policy and Conservation Act of 1975, the Department of Transportation is considering revision of post-1985 fuel economy standards for automobiles to require more efficient cars. In his July energy program the President announced his commitment to invest $200 million for improving automobile efficiency. The President has also proposed a $6 billion 10-year program to provide subsidies for loans to moderate and low income families for conservation investments. These loan subsidies and the conservation tax credits enacted in November 1978 provide significant incentives for improving residential energy conservation.

The Harvard study, *Energy Future* [12], reached conclusions similar to those of CEQ in *The Good News About Energy*. The Harvard report found that over the longer run the United States can use 30 to 40 percent less energy than it now does with "virtually no penalty for the way Americans live." If this improvement in energy productivity is achieved, the environment will be less strained, the dollar will be under less international pressure, many billions of dollars of capital investments in energy supply technologies can be saved, dependence on OPEC oil will be reduced, and western society will be less likely to suffer internal and external tension.

The report concluded that the current U.S. price structure for energy is heavily distorted, putting conservation at a disadvantage. The price of imported oil fails to represent its true cost to the nation in terms of insecure supply, strained relations with other nations that compete for the same oil, and the potential for sudden, jarring price increases. The report also stated that many of the social and environmental costs of conventional energy sources are not reflected in their prices. Furthermore, domestic energy prices have been held "below their economic value" by controls on oil and gas prices, and by utility regulation that prices electricity below replacement costs. Consumers are thus receiving enormous price subsidies to use domestic sources of conventional energy.

These retarding effects of price controls on national energy productivity were recognized by President Carter in his May 1977 National Energy Plan. Replacement cost pricing was a basic principle underlying the Plan and remains an important element of national energy policy. Phased decontrol of natural gas and oil prices will have the effect of making energy prices more closely reflect their replacement values.

To give conservation a fair chance to compete in the marketplace with imported oil and other traditional sources, the Harvard report recommended financial incentives to encourage conservation, and

strong government leadership to overcome failures to internalize the external costs. The report made these specific proposals:

- In transportation, stronger fuel-efficiency standards for automobiles and trucks that do not hamper flexibility and experimentation should be set for the post-1985 period;
- In the industrial sector, government should consider offsetting payments for conservation investments in the form of investment tax credits and accelerated depreciation up to 40 percent of capital costs; and
- In the residential/commercial sector, the government should consider conservation tax credits for retrofit of energy-saving investments in existing buildings, up to 50 percent of the costs, with rebates for lower income groups.

The report noted that the same institutional barriers hampering investments in conservation also impede the development of solar energy. It recommended financial incentives to encourage solar energy as well.

Several federal initiatives addressing these issues are underway, including the DOT review of post-1985 fuel economy standards, measures to encourage conservation in residential and commercial buildings, and the wide range of economic incentives for solar energy launched by the President's June 1979 Solar Message. In addition, the President has proposed the $6 billion loan subsidy program described above. This program would also expand the energy audit program established by the National Energy Act.

DOMESTIC ENERGY SUPPLY

OIL AND GAS

Phased Decontrol of Oil

Under existing federal law, price controls on oil will expire on September 30, 1981.[13] Using his authority to modify existing requirements, the President decided in April 1979 to soften the economic shock of a sudden lifting of price controls, by phasing out controls at a fairly uniform rate over a 28-month period beginning in June 1979 and ending in September 1981. This action is intended to encourage domestic production and the more efficient use of our limited petroleum resources while improving energy efficiency and thereby reducing consumption.

At the same time, the President asked Congress to enact a windfall profits tax on oil producers. He proposed placing the funds collected in an Energy Security Trust Fund that would be used to assist low-income households, expand support for mass transit, and provide government help to the private sector to commercialize a wide range of energy technology programs.

NEA Oil and Gas Provisions

The National Energy Act directly affects the use of oil and natural gas in several important ways. First, under the Power Plant and Industrial Fuel Use Act of 1978, oil and gas may not be used as a primary energy source in new large industrial boilers or new electric generating plants, unless DOE specifically grants an exemption for their use.[14] In addition, DOE may require existing facilities to use coal if possible, and if not, to use coal-oil mixtures. The law provides that most uses of natural gas to fuel power plants must be phased out by 1990, and meanwhile, the electric utility industry may not use more gas, in proportion to total fuel consumed, than it did in 1974 to 1976. However, in view of current better prospects for natural gas supplies, the possibility of using the law's exemption provisions to postpone the phaseout of natural gas is being debated. The gas situation is discussed below.

Second, the Energy Tax Act of 1978 is intended to discourage industrial use of oil and gas.[15] Investment tax credits and accelerated depreciation will be restricted for new oil- and gas-fired boilers, and a rapid depreciation will be allowed to encourage the early retirement of existing oil- or gas-fired boilers. Furthermore, gasohol—an alcohol/gasoline mixture that can fuel cars and trucks—will be exempt from the federal gasoline excise tax. The federal income tax credit for excise taxes on gasoline used for nonbusiness or off-highway uses will be abolished. And the tax credit for intangible drilling costs for oil and gas will be extended in its present minimal form, not enlarged.

The Natural Gas Policy Act of 1978 ends the 25-year-old federal regulatory regime that distinguished between intrastate and interstate gas and controlled prices of the latter.[16] Price controls will be lifted by category of use, with increases to residential consumers coming slowly and industrial users the first to pay higher prices. The price of new natural gas will be decontrolled on January 1, 1985.

In sum, these parts of the National Energy Act are expected to encourage increased gas production and to speed the substitution of coal for scarce oil and gas resources.

Natural Gas Surplus

At the same time, the prospects for natural gas supply are now considered brighter than they have been in the recent past. Indeed it appears there will be a short-term surplus. There are two principal reasons: first, because the distinction between interstate and intrastate gas has been eliminated, the longstanding excess intrastate capacity will now be available for interstate use.[17] In early 1979 this excess was estimated at about 1 trillion cubic feet a year (about 1 QBtu per year), or about 5 percent of our current natural gas consumption. Second, industry has markedly reduced its gas consumption as a result both of conservation efforts and of switches from gas to oil during the recent period when gas supplies were low and un-

certain. From 1977 to 1978, for instance, industrial use of natural gas declined by roughly 0.5 QBtus.[18]

This "bubble" of excess gas supply can be used as a substitute, at least temporarily, for about 5 percent of our imported petroleum oil imports, or roughly 0.5 million barrels a day. This temporary benefit may complicate the longer-term policy objective of using coal instead of oil or gas for electric power plants and big industrial boilers. However, the respite may provide an opportunity to devise better ways to use coal, with fewer hazards to health and the environment.

DOE is developing flexible responses to the changing conditions. Industries and utilities with alternative fuel-burning capability will be strongly encouraged to burn gas instead of oil in the immediate future.[19] DOE has already proposed an exemption to the National Energy Act to allow power plants to convert from fuel oil back to gas.

Unconventional Natural Gas

In his July 15 address the President included increased production from unconventional natural gas resources as one important means to reduce imports by 1990. He proposed significant new incentives to encourage production from unconventional natural gas resources, which include: methane obtained from deep gas structures below 15,000 feet; methane from coal seams; western "tight" gas sands, that is, gas in geologic structures with very low permeability, which does not readily flow laterally to wells; gas in Devonian shales in the Appalachian Basin; and geopressurized methane associated with geothermal resouces. There are technical difficulties in the way of exploring some of these gas resources, and they are generally more costly to produce than conventional gas. However, with rising energy prices unconventional natural gas is steadily becoming more competitive, and federal R&D (research and development) assistance will help overcome technical barriers.

This resource is expected to play an increasingly larger role in the coming decades. The Administration's energy program seeks production of 500,000 to 1 million barrels per day oil equivalent of unconventional gas, with possible contributions ranging well above this level.[20]

The environmental effects of producing deep gas resources should be very similar to those of conventional production and, thus, should be relatively minor. The same is true of producing methane from coal seams, which could have the added advantage of making underground mining safer.

Environmental problems of extracting gas from tight gas sands and Devonian shales are reasonably well understood and appear to be controllable.[21] The process is not likely to contaminate surface or ground water, nor will it violate federal air quality, at least during initial operations. There is a potential risk of chemical contamination in fracturing the rock formation, but the risk can be lowered by sub-

stituting less hazardous substances. Many of these risks can be reduced simply through careful industrial practices; very little if any control-technology hardware development appears necessary.

The principal environmental problems in producing geopressurized methane are related to the disposal of large amounts of brine. The problems could be more significant than those from other gas sources, but are still uncertain and require more analysis.

OCS Oil and Gas

Production from the Outer Continental Shelf (OCS) supplies limited but important amounts of oil and a larger share of our natural gas. OCS oil production under federal jurisdictions in 1977 was estimated to be about 830,000 barrels per day or roughly 5 percent of domestic oil consumption; 1977 OCS gas production was estimated at about 3.7 trillion cubic feet, nearly 20 percent of U.S. total supplies.[22] Alaska and the OCS are thought to be the nation's last frontiers for major new oil and gas finds. Estimates by both government and industry suggest that 60 percent of the undiscovered oil and natural gas resources of the United States may be located in the OCS.[23]

OCS exploration has stepped up markedly since the early 1970s but the results in new, previously unexplored areas have been discouraging. Prospects for the Baltimore Canyon—the OCS region from New York to Delaware—dimmed with the announcement of several dry holes. The area covered by the first lease sale in the northeastern part of the Gulf of Alaska, considered a highly promising area, has not yet panned out. By the end of June 1979, 11 dry holes had been drilled and there were no discoveries of oil and gas. In fact, recent geophysical data suggest that commercial quantities of oil and gas may not exist there.[24] These disappointing results, when added to earlier ones for the eastern Gulf of Mexico and for new areas off southern California, suggest that future OCS production may not be as large as had been predicted earlier.

Preliminary DOE estimates of oil and gas production for the period from 1985 to 1995 suggest that the fraction of our energy needs supplied by the OCS will continue to be rather small.[25] After a modest decline between now and 1985, OCS oil production could increase to roughly 1.8 million barrels a day in 1990 to 1995 depending on economic conditions at that time. Natural gas production from the OCS is projected to decline slowly through about 1990 and then fall off more rapidly, probably providing only about 1.9 QBtus in 1995. Current estimates are far less optimistic than those made in the mid-1970s.

In an effort to increase OCS oil and gas production, the President's Energy Message of April 1979 directed the Secretary of the Interior to propose additional acreage to the existing leasing schedule. Before this directive, the U.S. Department of Interior had already planned to offer a total of 14.5 million acres for 1979 to 1981. Present plans

are to offer 26 million acres for the 5-year period beginning March 1980. By way of comparison, during 1976 to 1978, 7.8 million acres were offered for sale.[26]

Under the OCS Lands Act amendments of 1978 the Interior Department is issuing new regulations for consultation with states before lease sales and for detailed consideration of environmental impacts.[27] A special problem raised in connection with U.S. development off southern California is the potential for increased air pollution in an area that has the nation's worst ozone smog problem. Even though OCS emissions are generally low, with minimal on-shore impact, even small increments of pollutants can pose a problem in areas with serious pre-existing air pollution difficulties. Measures to control emissions of air pollutants from all aspects of OCS operations—rigs, platforms, and tankers—are under consideration.

Some of the lease sales planned for the next few years are in forbidding environments where offshore experience is scanty and the risks are great. An example is the Arctic waters of Alaska's Beaufort Sea. Yet it is just here that the oil and gas resource is thought to be exceptionally rich, a possible seaward extension of the huge Prudhoe Bay field that is now being produced. Exploration and development of such areas will require a high degree of sophisticated environmental planning.

Petroleum Transportation Issues

Alaskan crude oil is a long distance from its biggest market. Produced in the most remote part of the United States, in Alaska's Arctic North Slope, the oil is transported by pipeline and tanker to the west coast. West coast refineries have a limited capacity to refine the heavy, high-sulfur Alaska oil, and there is at present no cheap and convenient means of sending Alaskan oil to northern tier and inland refineries that are starved for crude oil and are equipped to process high-sulfur oil. There has also been a surplus of crude oil on the west coast in relation to demand. Until early 1979, west coast demand had grown more slowly than planners of the Alaska pipeline had anticipated. Alaskan crude was pouring in at the rate of 1.2 million barrels a day, and a surplus of 400 to 600 thousand barrels a day had developed.[28]

Despite the shortages of gasoline that appeared in California in late spring 1979, it appeared that west coast refineries still could not take all of Alaska's crude. Meanwhile crude imports from Canada to Chicago area refineries have dropped, and inland refineries in general are more dependent than ever before on crude oil imports, as U.S. production in the lower 48 states continues to decline.

Alaskan crude now reaching eastern and midwestern markets comes via tanker through the Panama Canal. But the possibility of pipelines from the west coast eastward is appealing because of potentially lower costs and greater convenience. New pipelines and extensions of existing ones are being planned.

These are some of the considerations that led Congress to include in the National Energy Act measures to expedite selection of a west-to-east transportation system for Alaskan crude.[29] The law provides that applications to provide the transportation systems, and the analyses supporting them, will be reviewed by the President. If a system is found to be in the national interest, it will receive expedited federal permits, including rights-of-way across federal lands. NEA also included a provision expediting federal approval of a west-to-east crude pipeline from Long Beach, Calif., to Midland, Texas, known as the PACTEX pipeline.

The PACTEX project was planned to deliver 500 thousand barrels a day of Alaskan oil from the west coast eastward. Under consideration for several years, the project was highly controversial. Hundreds of state and local permits and a few federal permits were required. Because Long Beach is in the South Coast Air Quality Basin—the worst for photochemical smog in the nation—pipeline officials had to offset expected new emissions of hydrocarbons with greater reductions from existing sources. Long Beach voters had to approve a referendum authorizing city and port officials to grant the permits for a terminal to receive North Slope crude, for transshipment via the pipeline. Citing a wide range of considerations, including the rising cost of buying and converting an existing pipeline, the project manager, the SOHIO Company, announced in mid-1979 its decision not to build the PACTEX pipeline.

Several other crude oil transportation routes both in the south and the north are being analyzed.[30] The Department of Energy and other agencies are evaluating these proposals against the NEA legislative criteria, which include: [31]

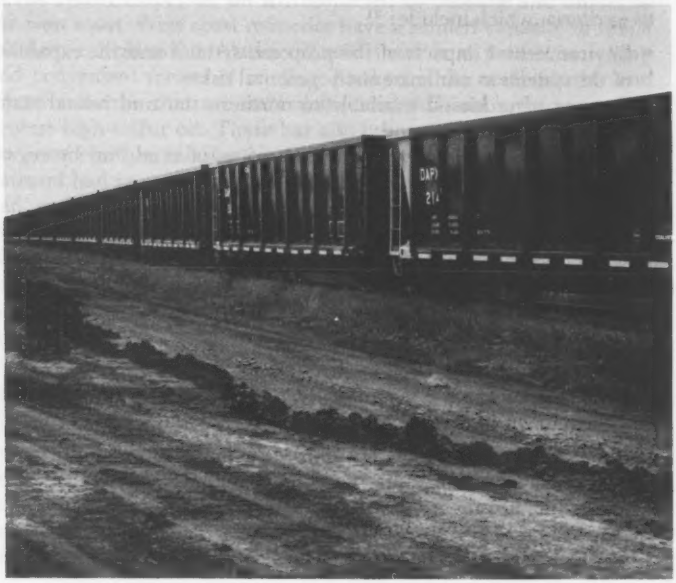
- Environmental impacts of the proposed systems and the capability of the systems to minimize environmental risks;
- Amount of crude oil available to northern tier and inland states and the projected demand;
- Transportation costs and delivered prices of crude oil by region under each system;
- Construction schedules and the possibility for delay;
- Net national economic costs and benefits of each system; and
- Effect of each system on international relations and its national security considerations.

The President is expected to complete his review by late 1979.

COAL

Coal is still energy in the bank for the United States. With our abundant coal reserves Administration policy is to lean more and more on coal as a substitute for petroleum and natural gas in coming years. The Powerplant and Industrial Fuel Use Act of 1978, part of the National Energy Act, seeks to encourage increased use of coal by several means. As noted, the Act prohibits use of oil or natural gas in new powerplants or in new large-scale industrial boilers unless the

Coal removed from the surface mine shown above, near Decker, Mont., is carried across country by 100-car unit trains (below). Each car carries 100 tons of coal. Photographer: James J. MacKenzie.



Department of Energy grants an exemption. It also streamlines the coal conversion procedures established by the Energy Supply and Environmental Coordination Act of 1974. Thus, efforts to make coal production and use as compatible as possible with environmental quality are of great interest.

Several issues related to coal and the environment have received considerable attention during the past year. Among them are the strip mining regulations under the Surface Mining Control and Reclamation Act of 1977; mine health and safety problems; the new federal coal leasing program; alternative means of transporting coal; and the environmental problems of coal conversion technologies—that is, of converting coal to electricity, gas, or oil.

Coal Mining Regulations

The Interior Department has issued regulations for surface coal mining and reclamation operations under authority of the Surface Mining Control and Reclamation Act of 1977.[32] The key purposes of the Act are:

- To establish a nationwide program to protect society and the environment from the adverse effects of coal mining;
- To prohibit mining where reclamation as required by the Act is not feasible;
- To insure that reclamation occurs as contemporaneously as possible with the mining;
- To strike a balance between protecting the environment and agricultural productivity and insuring adequate coal production;
- To assist the states in developing, administering, and enforcing regulatory programs that achieve the purposes of the Act;
- To achieve reclamation of areas previously mined; and
- To provide appropriate procedures for public participation in the development of regulations, standards, and programs under the Act.

The final rules under the Act, issued in March 1979, cover three major areas:[33] (1) performance standards to protect the environment and public health and safety, permit applications, and bonding requirements for surface coal mining and reclamation operations; (2) the procedures for preparation, submission, and approval of state programs to control mining and reclamation; and (3) development and implementation of a federal program for any state that does not develop an acceptable program.

The performance standards set forth in the Act, and implemented in the regulations, apply to surface coal mining operations and reclamation afterward, surface effects of underground coal mining, surface coal mining in special areas or in special circumstances (such as mining in alluvial valley floors, on prime farmland, and on steep slopes). The regulations specifically require:

- Conservation of resources;
- Surface area stabilization;

- Restoration of prime farmland;
- Waste disposal;
- Contemporaneous reclamation;
- Revegetation;
- Offsite area protection;
- Spoil disposal;
- Fish and wildlife protection; and
- Slide or erosion barriers.

The regulations have been the source of much controversy. When they were published in draft form in September 1978 they were immediately assailed by the mining industry for what it considered excessive stringency and costliness.[34] Environmental organizations generally supported the draft regulations.

In January 1979, after the period for public comment on the regulations had closed, Department of the Interior officials met with staff representatives of the President's Council of Economic Advisors (CEA) and other groups to discuss possible inflationary aspects of the regulations.[35]

The environmental groups filed suit asking for an injunction to stop off-the-record meetings and to require Secretary Andrus to disregard all arguments and data presented by CEA and others after the close of the comment period. The court dismissed the initial suit because the strip mining regulations had not been published.[36] A similar but broader suit was filed in April 1979 by seven environmental groups. The suit contended that because of the ex parte involvement by CEA, the specific provisions of the regulations that CEA had discussed with Andrus should be held invalid.[37] These included air and water quality standards, restrictions of mining in alluvial valley floors, and procedures for federal approval of state enforcement programs.

Meanwhile, in February a Federal District judge in Arlington, Va., temporarily restrained the federal government from enforcing the mining regulations in Virginia.[38] In the first suit brought against the federal surface mining regulations, the Virginia Surface Mining and Reclamation Association, Inc., charged that provisions of the 1977 Act are unreasonable, violating the protection of the Fifth Amendment to the Constitution against the taking of private property without due process. The Governor of Virginia called the federal regulations a "massive land-use zoning program" that has gone beyond protection of the public interest.[39] A similar suit is pending in Indiana.

Mine Health and Safety

Coal mining has a long and tragic history of deaths, injuries, and work-related illnesses. Despite the requirements of the Coal Mine Health and Safety Act of 1969, and the efforts of the Mine Safety and Health Administration, underground coal mining continues to be one of the nation's most hazardous occupations. As Table 5–4

shows, preliminary figures identify 105 fatal and 13,554 nonfatal injuries in coal mining in 1978. From 1930 to 1978 the frequency of injuries and fatalities declined substantially. Nevertheless, compared with most industries, coal mining still has very high accident rates.

Surface coal mining is considerably less hazardous than underground mining. Table 5–5 breaks down these differences for the years 1974 to 1977 in some detail. A company-by-company examination of major coal producers reveals wide variations in injury rates for underground coal mining. In 1977, these rates ranged from 8 to 111.2 injuries per million employee hours. This kind of variation has been reported since at least the early 1970s (see Table 5–6). The injury rates at the low end of the range are no higher than those for such occupations as retail trade and higher education. The implication, since some companies are able to achieve such low injury rates, is

Table 5–4

Injury Experience in Coal Mines, 1930–77

Year	Number of Injuries		Frequency Rates			
			Per Million Employee Hours		Per Million Tons	
	Fatal	Nonfatal Disabling	Fatal	Nonfatal Disabling	Fatal	Nonfatal Disabling
1930	2,063	99,981	1.87	90.65	3.84	186.22
1931	1,463	77,958	1.66	88.26	3.31	176.47
1932	1,207	56,283	1.73	80.50	3.36	156.53
1933	1,064	59,129	1.34	74.58	2.78	154.31
1934	1,226	65,559	1.43	76.63	2.94	157.39
1935	1,242	63,426	1.52	77.43	2.92	149.37
1936	1,342	67,540	1.45	72.91	2.73	137.52
1937	1,413	66,259	1.55	72.62	2.83	132.84
1938	1,105	49,636	1.59	71.36	2.79	125.44
1939	1,078	51,773	1.42	68.12	2.41	115.57
1940	1,388	57,776	1.65	68.75	2.71	112.67
1941	1,266	61,057	1.37	66.26	2.22	107.14
1942	1,471	66,774	1.44	65.40	2.30	104.33
1943	1,451	64,594	1.40	62.44	2.22	98.92
1944	1,298	63,691	1.20	59.06	1.90	92.99
1945	1,068	57,117	1.11	59.58	1.69	90.44
1946	968	55,350	1.10	62.92	1.63	93.19
1947	1,158	57,660	1.22	60.72	1.60	84.16
1948	999	53,472	1.11	59.53	1.54	82.26
1949	585	35,405	.91	55.11	1.22	73.93
1950	643	37,264	.90	52.38	1.14	66.27
1951	785	35,553	1.13	50.99	1.37	61.84
1952	548	30,074	.92	50.66	1.07	58.97
1953	461	24,258	.90	47.23	.95	49.87
1954	396	17,718	1.02	45.67	.94	42.10
1955	420	18,885	1.00	45.03	.85	38.43
1956	448	19,816	1.03	45.69	.85	37.50
1957	478	18,792	1.17	46.04	.93	36.51
1958	358	14,160	1.11	43.94	.83	32.76
1959	293	12,163	.99	41.09	.68	28.12
1960	325	11,902	1.15	42.28	.75	27.36

Table 5–4 (continued)

Year	Number of Injuries		Frequeucy Rates			
			Per Million Employee Hours		Per Million Tons	
	Fatal	Nonfatal Disabling	Fatal	Nonfatal Disabling	Fatal	Nonfatal Disabling
1961	294	11,197	1.15	43.86	.70	26.61
1962	289	10,944	1.16	43.96	.66	24.87
1963	284	11,133	1.12	43.97	.59	23.26
1964	242	11,070	.96	43.86	.48	21.90
1965	259	11,138	1.04	44.73	.49	21.09
1966	233	10,446	.96	42.85	.43	19.15
1967	222	10,115	.92	41.84	.40	18.04
1968	311	9,639	1.33	41.12	.56	17.42
1969	203	9,917	.85	41.76	.36	17.42
1970	260	11,552	1.00	44.40	.43	18.94
1971	181	11,916	.71	46.89	.32	21.18
1972	156	12,329	.58	46.08	.29	23.06
1973	132	11,220	.48	40.41	.24	20.11
1974	133	8,545	.45	28.79	.24	15.10
1975	155	11,107	.42	30.17	.25	18.17
1976	141	14,389	.37	37.55	.22	22.24
1977	139	14,989	.36	38.37	.21	22.35

Notes: A "disabling injury" is one that causes a miner to miss one or more days of work. "Disabling injuries" are not to be confused with "permanently disabling injuries." MSHA is dependent on operators' compliance with reporting requirements for data on disabling injuries. Preliminary data for 1978 indicate that there were 105 fatalities at coal mining operations in 1978, for a preliminary fatality rate of 0.30 per million man-hours. There were 13,554 reported "nonfatal injuries with days lost," a category not entirely comparable with "nonfatal disabling injuries" because it also includes injuries that cause a miner to engage in restricted work activity for one or more days. The preliminary rate for "nonfatal injuries with days lost" is 36.95 per million man-hours.

Source: U.S. Department of Labor, Mine Safety and Health Administration, *Injury Experience in Coal Mining, 1977* (Washington, D.C.: U.S. Government Printing Office. 1979) Information Report 1098, Table 51.

that mining is not inevitably a dangerous occupation; it can be made reasonably safe.

During the past 2 years, there have been considerable efforts to improve federal programs for mine health and safety. In November 1977, President Carter signed into law the Federal Mine Safety and Health Amendments Act, which brought all U.S. mines—more than 20,000 underground and surface, coal and noncoal facilities—under a safety and health regulatory program.[40] The Interior Department's Mining Enforcement and Safety Administration was transferred to the Department of Labor and renamed the Mine Safety and Health Administration (MSHA).

The 1977 Act considerably extended federal mine safety activities. It required new or revised safety and health regulations for mining activities. All underground mines are now required to have a complete health and safety MSHA inspection at least four times a year and all surface mines are to be inspected at least two times a year.

Table 5–5

Number of Injuries and Frequency Rates Per Million Employee-Hours for Coal, 1974–77

	Fatal		Nonfatal		Total Disabling	
1974	No.	Rate	No.	Rate	No.	Rate
Underground	97	0.51	6,689	34.95	6,786	35.46
Surface	26	.35	1,267	16.85	1,293	17.20
Independent Surface and Yard	—	—	82	14.77	82	14.77
Mechanical Cleaning Plants	10	.41	507	20.56	517	20.97
Total	133	.45	8,545	28.79	8,678	29.24
1975						
Underground	111	.47	8,687	37.13	8,798	37.60
Surface	35	.36	1,760	17.86	1,795	18.21
Independent Surface and Yard	—	—	89	13.62	89	13.62
Mechanical Cleaning Plants	9	.31	571	19.60	580	19.91
Total	155	.42	11,107	30.17	11,262	30.59
1976						
Underground	109	.45	11,390	47.09	11,499	47.54
Surface	24	.23	2,108	20.08	2,132	20.31
Independent Surface and Yard	—	—	114	16.60	114	16.60
Mechanical Cleaning Plants	8	.27	777	26.41	785	26.68
Total	141	.37	14,389	37.55	14,530	37.92
1977						
Underground	100	.43	11,724	50.86	11,824	51.29
Surface	29	.24	2,277	18.93	2,306	19.17
Independent Surface and Yard	1	.15	126	18.57	127	18.72
Mechanical Cleaning Plants	9	.27	862	26.13	871	26.41
Total	139	.36	14,989	38.37	15,128	38.73

Source: U.S. Department of Labor, Mine Safety and Health Administration.

Other enforcement activities include mandatory training of miners, mine rescue, and the control of harmful physical agents.

Coal Leasing

Resumption of long-term leasing of federal coal lands has been much discussed in connection with national energy goals. The actual need for long-term leasing has not been easy to determine. About 24 billion tons of federal coal is already under lease, but coal produced from these lands in 1978 was only about 60 million tons, plus 19 million tons from Indian lands. Federal long-term leasing was suspended in 1971, because little coal was being produced from the existing leases and also because of environmental concerns.

The Department of the Interior since that time has developed a comprehensive new coal leasing program. On June 4, 1979, Secretary

Table 5–6

Underground Mine Injury Rates for Major Coal Producers

(nonfatal injuries per million man-hours)

	1972	1973	1974	1975	1976	1977
Peabody	53.7	50.2	23.3	26.9	34.6	40.8
Consolidation	54.5	19.0	9.5	10.8	16.0	14.2
Island Creek	33.1	22.2	12.1	11.5	11.7	20.8
Pittston	85.1	73.5	27.1	27.1	23.0	24.6
U.S. Steel	5.3	7.0	4.0	6.1	9.3	8.0
Eastern Associated	107.6	115.1	89.9	75.8	83.9	111.2
Bethlehem	9.0	7.9	9.3	17.0	36.9	39.8
North America	96.4	89.3	58.8	61.1	72.7	73.1
Westmorland	—	—	88.8	106.7	109.9	123.6
Old Ben	49.7	44.3	21.2	20.5	21.8	23.4

Sources: U.S. Department of the Interior, Mining Enforcement and Safety Administration; U.S. Department of Labor, Mine Safety and Health Administration.

of the Interior Cecil Andrus announced the new program, which includes eight major elements:

- A planning system, involving close consultation with state and local governments, industry, and the public—first, to decide which areas of federal coal reserves would be considered acceptable locations for coal production and, second, to delineate, rank, and select for sale specific tracts of coal;
- A system for evaluating the national demand for coal and for determining the volume of production that the leasing of federal coal should stimulate;
- Procedures for conducting sales and issuing leases;
- Post-lease enforcement of terms and conditions;
- Procedures for management of existing leases issued prior to implementation of the new program;
- Procedures for processing existing preference right lease applications;
- A strategy to integrate the environmental analysis requirements of the National Environmental Policy Act of 1969 in the new program; and
- Procedures to start up the new program and to offer lease sales in emergency situations.

The Department of the Interior intends that strict environmental controls will apply to mining under the new plan. All federal coal lands will be reviewed initially to screen out environmentally unsuitable lands. Such areas include prime farm lands, potential wilderness regions, and important wildlife habitats. Federal lands that have small coal reserves or pose potential conflicts with neighboring landowners will also be eliminated. After these areas are removed from

consideration, coal companies and states will propose specific areas for leasing.

The Interior Department will then conduct detailed analyses and rank the proposed areas so as to identify those that have the least environmental and social impacts and the most recoverable coal. These tracts will then be leased as needed to meet production goals determined by DOE.

Once the new leasing program is in full operation, which could be as early as 1985, situations might arise in which the full planning-through-sale cycle could not respond quickly enough to avoid uneconomic bypassing of coal seams, or inequitable losses for existing coal operations. To take care of such situations, an emergency leasing system will be able to offer individual leases for small amounts of coal, to avoid bypassing or to maintain existing operations.

Coal Transport

Some highly significant environmental issues arise in relation to the transport of coal. When coal is produced in areas with low energy demand—as for example in the richly endowed but lightly populated Powder River Basin of Montana—then the coal, or energy derived from it, must be transported to where it will be used. It is possible to convert the coal at the mine site to a more easily transportable form—electricity, synthetic gas, or synthetic oil. However, all of the onsite conversion alternatives have substantial problems: long distance electrical transmission is expensive and the cooling water required by electric power plants may be nonexistent in the water-short West; the technologies for gasifying or liquefying coal are primitive and expensive.

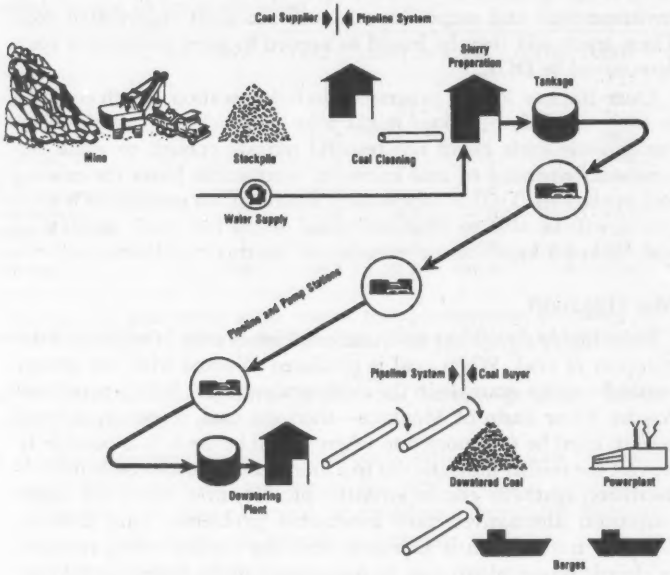
The two principal alternatives for transporting large amounts of coal long distances are unit trains, which are devoted solely to carrying one commodity, and coal slurry pipelines, which use water or some other liquid to transport pulverized coal through an underground pipe (see Figure 5–3 for a schematic description).

Each alternative has its own economic and environmental pluses and minuses. Unit trains have relatively low requirements for new capital expenditures but substantial operating costs that, unlike sunk capital costs, increase with inflation. Slurry pipelines require large initial capital investments, which can, however, be amortized at a predictable rate; operating costs are generally low. Slurry pipelines tend to have an economic advantage over unit trains under the following circumstances: [41]

- The distances to be traversed are long;
- The annual volumes of coal to be shipped are high;
- Anticipated rates of inflation are high and interest rates are low;
- Mines are large and have secure markets of several large customers; and
- Water is available in sufficient quantities and at low cost.

Figure 5–3

Schematic Description of Slurry Pipeline System



Source: John M. Huneke, Testimony before the House Committee on Interior and Insular Affairs on Coal Slurry Pipeline Legislation, Washington, D.C., September 12, 1975.

The environmental impacts of the two alternatives are quite different.[42] The primary impact of unit trains is their disruptive influence on the lives of people living or working near the track. Among the most important impacts are train noise, interruption of commuter and other automobile traffic, increased number of accidents at grade crossings, and interference with cattle movements. In order to transport 36 million tons of coal annually—enough to supply about 10 large power plants—a total of nearly 20 unit trains (10 in each direction), each approaching a mile in length, would need to pass a fixed location each day.[43] Many of the adverse impacts can be reduced through highway improvements, cattle passes, and improved land use planning.

The principal environmental concern about slurry pipelines is their need for continual supplies of large amounts of water.[44] In the West where coal is abundant and water is scarce and highly valuable, the demand of a slurry pipeline for water could be a very serious problem. A pipeline transporting 30 million tons of coal a year, for instance, would require about 10 to 20 thousand acre-feet of water

each year.[45] This is enough water to irrigate roughly 5 to 10 thousand acres of farmland a year. In principle, it might be possible to recycle the water used in the slurry by building another pipeline to carry the water back to the mine, but the costs would be substantial. Other environmental concerns include the more transient impacts of pipeline construction. These impacts may have considerable importance in lightly populated areas where community facilities for an influx of construction workers are limited.

A federal effort to give slurry pipelines the right of eminent domain, under certain circumstances, proved highly controversial. In mid-1978, the House of Representatives defeated by a large margin (246 to 161) an Administration-supported bill that would have given the right of eminent domain to qualified pipeline companies.[46] Nevertheless, plans are still going forward to build at least a few of the slurry pipelines that have been proposed[47] (see Figure 5–4). Energy Transportation Systems, Inc. is continuing with plans to build a Wyoming-to-Arkansas line. Houston Natural Gas hopes to build a line linking Colorado with Houston.

Synthetic Fuels from Coal and Oil Shale

The President's July 15 Message proposed major initiatives to improve our conservation efforts, increase the production of domestic

Figure 5–4

Coal Slurry Pipelines: Present and Planned

Source: *Coal Age* (June 1978).

oil and gas, and make solar energy a more important source of energy in the United States.

In addition, to help provide new sources of fuel for transportation and to reduce U.S. dependence on imported oil from insecure sources, the President proposed a large-scale effort to help private industry develop our enormous reserves of unconventional natural gas and to produce synthetic fuels from biomass and our abundant domestic coal and oil shale resources. He also proposed the establishment of an Energy Security Corporation to carry out the effort.

In 1978, the United States imported more than 8 million barrels per day of crude oil and petroleum products—13 percent of total world oil production and about 42 percent of total U.S. oil consumption—at a cost of $42 billion. The Iranian oil production shutdown and the 60 percent increase in world oil prices by OPEC by June 1979 demonstrated the vulnerability that results from such a large dependence on imported oil.

Actions taken and programs proposed by the President since 1977 under the National Energy Act and the April 5, and July 15, 1979 energy messages are expected to gain the equivalent of 6 million barrels per day of oil production by 1990 from residential and commercial conservation, mass transit, increased auto efficiency, conversion of powerplants to fuels other than oil, additional domestic oil and gas production, and incentives for production of heavy oil. However, it is estimated that other sources of energy are needed to meet the goal of cutting oil imports by half by 1990.

According to the Fact Sheet on the President's July 15 program, if all measures other than the synthetic fuel and unconventional gas measures proposed by the President were enacted by Congress, U.S. imports would probably reach 6.5 to 7.5 million barrels per day in 1990. These imports would equal 10 percent of the world's oil production in 1990.

To provide additional energy supplies to further reduce imports and increase our economic and political independence from foreign oil sources, and to ensure against the possible failure of other programs to reduce oil to the desired level, the President proposed aggressive development of synthetic fuels. Development of synthetic fuels would:

- Provide a supply of liquid fuels that cannot be cut off and is not directly subject to OPEC's price increases.
- Reduce massive dollar payments from the United States to OPEC countries, thereby also reducing balance of payments problems and downward pressures on the dollar in world currency markets.
- Improve national security and reduce vulnerability to political pressures from oil producing countries.
- Slow down world oil price increases because of the decrease in world oil demand.

The President proposed that a major portion of the large revenues expected from the Windfall Profits Tax be committed to an independent, congressionally chartered Energy Security Corporation. The Corporation's purpose would be to assist the development, by the private sector, of synthetic fuels and unconventional natural gas. To accomplish its purpose, the Corporation would be empowered to make direct loans, or to use loan guarantees, price guarantees, or purchase agreements.

The possible environmental risks of converting coal and shale to oil or gas are significant. Besides the possible hazards from toxic trace metals and organic carcinogens—both in the conversion process and in the oil and gas products—there are also troubling questions of land and water use involved in these technologies. In addition, synfuels contribute proportionately more than other fossil fuels to increasing concentrations of carbon dioxide in the earth's atmosphere. With the development of synthetic fuels, these problems will have to be faced, and environmental protections built into the process of developing the technologies.

In a January 1979 report, the Department of Energy identified serious pollution problems that might arise in producing oil or gas from coal.[48] As Table 5–7 notes, the most serious pollution problems identified for coal gasification are as follows:

- Carcinogenic compounds and toxic trace metals are known to be present in gasification products, byproducts, and emissions; and
- Disposal of solid wastes in sanitary landfills may not be possible because some of the material is likely to contain toxic, mutagenic, and carcinogenic compounds.

The most important pollution concerns with liquefaction of coal, listed in Table 5–8, are similar to those for gasification:

- Liquid coal products are known to contain trace metals and organic carcinogenic compounds that may pose serious health problems; and
- The large quantities of solid waste generated by liquefaction processes are likely to contain toxic, mutagenic, and carcinogenic materials.

With strict controls, direct emissions of contaminated water from synthetic fuels plants can be minimized by recycling and using waste treatment ponds. A more difficult problem is likely to be water pollution due to leaching of solid wastes from mining and processing. These wastes consist of mineral residue, sludge from water treatment, particulates, char, and heavy tar residues, some of which are known or suspected carcinogens. Many are toxic to aquatic and terrestrial flora and fauna. Further research is needed to determine the seriousness of this problem.

Although differences in emissions from synthetic fuels and conventional fuels are not fully identified, the main differences may be the

Table 5–7

Some Environmental Concerns With Coal Gasification

Environmental Concerns	Status (state of knowledge) [a]	Likelihood of a Finding Adverse to Technology Development [b]	Environmental Risk of Proceeding with Technology Development
	Process Materials		
Gasification products, byproducts and process stream releases may pose a unique set of public health risks and environmental impacts during their production, transport, and use, and as a result of chemical/biological transformation mediated by environmental factors. Process materials and their transformants have not been adequately characterized and their toxicity relative to materials from both conventional and alternative synfuel processes is not established. Organics of concern may include sulfur- and nitrogen-containing compounds, polycyclics, and organometallic compounds. Trace metals of unknown toxic potential may also be present in these materials. Data will be needed to develop evolving regulations for public health and environmental impact.	Coal tar and pitches and volatile hydrocarbon emissions from processes producing or using them are regulated by OSHA to air exposure limits of 0.2 mg/m³. Skin exposure is controlled by use of protective clothing and specified hygiene practices. The regulation is based on the knowledge that several carcinogenic PAHs are present in these substances and from estimates of carcinogen potency of PAHs. A number of other hydrocarbons may be more potent carcinogens (heterocyclics) than PAHs and may be more stringently regulated for air exposure. Skin exposure will be controlled by protective clothing. DOE should have independent evaluation of risk for all potentially toxic and carcinogenic materials in the workplace.	Medium—Medium likelihood of finding carcinogenic hydrocarbons and trace metals in tars, byproducts, and residues from gas cleanup that are more potent carcinogens than surrogate PAHs used as basis for present regulations. May require more stringent regulations and control and monitoring in workplace.	Industrial hygiene is practiced in pilot plant operations. The adequacy must be determined as part of scaling up in development. Data will be available for one small high and low Btu gasification process by FY 1980 (Hygas pilot plant and MERC gasifier) and for a small low Btu "gasifier for industry" by FY 1982. There may be severe problems in extrapolating risk data to large-scale commercial plants.

Liquid Waste			
Quench waters from gasifiers contain a range of organic and trace metals which may be classified as toxic and exceed future TSCA limits. These may require special treatment. Wastewater treatment at existing facilities meets current standards. Changes in regulation and unknown scale up factors may require modification of methods.	Quench and clean up waters contain condensed volatile organic and inorganic materials including regulated and nonregulated hazardous agents such as PAHs at low concentrations. State-of-the-art treatment controls regulate organics adequately. Little is known about control of carcinogens that could be regulated under RCRA, or how industry can cope with handling the volumes of liquid waste which might require special handling and disposal. Recycling is an attractive alternative.	High—Highly likely that low levels of carcinogenic and mutagenic agents will be found in quench and process waters. If proposed RCRA detection protocols are used, the wastewater could be classified as toxic.	Preliminary identification of toxic, carcinogenic, or mutagenic agents can be completed by FY 1981 or 1982. Such data can be used to guide development of improved control methods. Unless unique toxic agents are identified, complete risk estimates will be available from other coal conversion processes by FY 1982–1983.

Table 5–7 (continued)

Environmental Concerns	Status (state of knowledge) [a]	Likelihood of a Finding Adverse to Technology Development [b]	Environmental Risk of Proceeding with Technology Development
		Solid Waste	
Waste management of solid residual (mineral residue, fines, bag-house particulates, evaporator pond sludges, char and heavy tar residues, spent catalysts, process reagents) must comply with evolving RCRA standards. Sanitary landfill may not be allowed if significant biological activity of waste products is found via screening tests.	Toxicity of most trace metals is established and TLVs exist for most of the metals in coal and effluents from coal and particulates. New guidelines are expected for Cd, Ni, As, and Cr based on their carcinogenicity. In some cases the carcinogenicity may be specified by valence state. A number of carcinogenic hydrocarbons will be in tar residues, including PAHs and more potent heterocyclics. The Ni compounds, sulfides, subsulfides and a number of organometallic compounds may be toxic at low doses under continuous chronic exposure. Specific control methods should be sought in anticipation of regulations which would specify	High—It is highly likely that some residues such as fine particulates and heavy tar residues will be found to contain materials which are toxic, mutagenic and carcinogenic. Rapid chemical and biological characterization can pinpoint the key problem wastes and aid in development of control methods. It is also likely that process solid wastes, from all sources, may contain materials whch can be leached from the residue, modified by factors in soil and water in ways which change their bioavailability and toxicity, and which will then pose unexplored/unexpected hazards of ecological impacts/environmental health.	Pilot plants can operate with special landfill disposal of bagged residues. Larger scale demonstration plants probably cannot operate in this way but will have to utilize organic residues for gasification. Early data to help identify relative hazards of the different problem wastes will be available for small gasifiers in FY 1980–1981.

	special disposal of large amounts of solid waste. Although metal composition and organic contents of ash and clinker from Lurgi process are known, leachability and consequent bioavailability of these classes of materials has not yet been studied and thus their ultimate environmental fate cannot be estimated. Present research would suggest that the nature of disposal sites will have to be factored into the evaluation process.

[a] With respect to present or proposed standards where such standards exist.
[b] Probability of Adverse Finding Low (0.1–0.3), Medium (0.4–0.6), High (0.7–0.9).

Source: U.S. Department of Energy.

Table 5–8

Some Environmental Concerns With Coal Liquefaction

Environmental Concerns	Status (state of knowledge) [a]	Likelihood of a Finding Adverse to Technology Development [b]	Environmental Risk of Processing With Technology Development
Process Materials			
Liquefaction products, byproducts, and process stream releases may pose a unique set of public health risks and environmental impacts during their production, transport, and use, and as a result of chemical/biological transformation mediated by environm ental factors. Process materials and their transformants have not been adequately characterized and their toxicity relative to materials from both conventional and alternate synfuel processes is not established. Organics of concern may include sulfur- and nitrogen-containing compounds, polycyclics, organometallic compounds. Trace metals of unknown toxic potential may also be present in these materials. Data will be needed to develop evolving regulations for public health and environmental impact.	Potential mutagenic (carcinogenic) polynuclear aromatic and heterocyclic hydrocarbons have been identified on coal combustion fine particulates and in various syncrude products. Effluents, "fugitive" emissions and SRC II product have not been completely characterized nor has the potential health risk associated with likely exposure of occupational force or general public been evaluated. Many of these same substances in SRC products, process solvents, and untreated aqueous emissions are of known toxicity to aquatic and terrestrial flora and fauna. In some cases (e.g. phenols) toxicity, metabolism, and transport and concentration in the ambient environment are known; in other cases (polycyclic sulfur and nitrogen-containing compounds) polyaromatic hydrocarbons data are not available and must be derived.	High—It is highly likely that carcinogens/mutagens will be found in various process steps and products. Many of these same materials are of known toxicity to aquatic and terrestrial flora and fauna and thus are of ecologic concern. OSHA regulations for workers, modified air and water quality standards, and the Toxic Substances Control Act may regulate such emissions and marketing of products and end use of refined fuels.	Research findings to assess health and ecological risk will not be available until FY 1983; pilot plant operations should not emit high levels of toxic agents. Preliminary data on toxicity and potential ecologic effects may become available in 1980 and may guide development and employment of improved controls. Data will also help for worker and ecosystem protection.

		Present OSHA standards limit worker exposure to PAH to 0.1 mg/m³ of air, and require air monitoring and use of protective measures to prevent skin contact with coal tar and by-products. Water treatment is adequate for phenols; it may not be for many nonbiodegradable polycyclic organic compounds.	
		Solid Wastes and Leachates	
Coal liquefaction solid wastes and residue will be produced at the rate of 200 pounds or more per ton of feed coal. These solid residuals include mineral residue, sludge from water treatment, baghouse particulates, char, heavy tar residues, and process reagents. Leachates from these materials will contain silicates, trace metals, in some cases hydrocarbons, nitrogen-containing compounds, and polynuclear aromatics. Environmental factors, by changing the chemistry of leached materials, may alter their toxicity and biological availability. Waste management practices for these residues will need to comply with evolving standards for RCRA.	A number of toxic metals and hydrocarbons in the workplace are regulated by OSHA standards. These standards are based on acute and subacute toxicity and are made more stringent for carcinogens. Data on low-level, long-term exposure for production of delayed toxicity, carcinogenicity are limited or unavailable. As, Ni, Be, Cd, and PAHs are suspect or known carcinogens. Although metal composition and organic contents of mineral residues from the SRC–I and II processes are known, leachability and consequent bioavailability of these classes of materials from these major solid wastes have	High—It is highly likely that a number of process residues and waste materials will be found to contain toxic, mutagenic, carcinogenic materials and pose work force, occupational and ecological risk. It is also likely that process solid wastes from all sources may contain materials which can be leached from the residue, modified by factors in soil and water in ways which change their bioavailability and toxicity, and which will then pose unexplored/unexpected hazards of ecological impact/environmental health.	Identification of those waste materials that can be classified as toxic will be completed in FY 1983. Early data on suspect toxic agents leaching from waste will be available by FY 1980–1981 and can guide development of better control methods. Data on environmental fate of materials in leachate, and the bioavailability and potential toxicity of transformed materials, will not be available until approximately 1984–85, well after the SRC–II demonstration plant might come on line.

Table 5–8 (continued

Environmental Concerns	Status (state of knowledge) [a]	Likelihood of a Finding Adverse to Technology Development [b]	Environmental Risk of Proceeding with Technology Development
	Solid Wastes and Leachates—(continued)		
	not been studied. Since gasification of SRC–II mineral residue has not yet been performed, fate of trace metals in final-processed SRC residue has yet to be determined. Present research would suggest, if SRC I and II mineral wastes are to disposed of by sanitary landfill, that the nature of the disposal site, its soil, ground water tables, rainfall, will have to be factored into the evaluation process. It is assumed that RCRA guidelines for hazardous waste control will place the burden of proof of compliance on industry and that special disposal may be required. Means should be found for early identification of toxic waste, for their separate processing to minimize volume, cost, and required special disposal methods.		

[a] With respect to present or proposed standards where such standards exist.
[b] Probability of Adverse Finding Low (0.1–0.3), Medium (0.4–0.6), High (0.6–0.9).

Source: U.S. Department of Energy.

higher concentrations of trace elements and aromatics in the synfuels. The potential for exposure of the general public to these trace elements during transportation, handling, and combustion of the final products may therefore be greater than with conventional fuels. This is a problem that requires careful attention.

The effects of synfuel development on land and water must also be carefully considered.[49] Assuming that the mix of domestic energy in 1990 includes about 1.25 million barrels per day of synthetic fuels derived from coal, about 25 plants would be needed to process the coal. Assuming further that three-fourths of the coal would come from strip mines in the West, about 500 square miles of land would be strip mined over the 30-year lifetime of the plants. Most of the mining would take place in Montana, North Dakota, and Wyoming where there are large amounts of low-cost coal suitable for strip mining. If the energy mix also included 400,000 barrels per day of synfuels from shale, about 100 to 200 square miles would be required for mining of the oil shale and disposing of the large volume of shale wastes. U.S. oil shale resources are concentrated in Colorado and Utah.

Land reclamation in the dry regions where much of the western coal and shale resources are located is difficult, and experience with the reclamation in these areas is limited. Knowledge of the potential effects of coal and shale mining on critical ground water resources is likewise limited. Compliance with existing surface mine regulations, however, and a continuation of basic research could lead to significant reductions in these impacts.

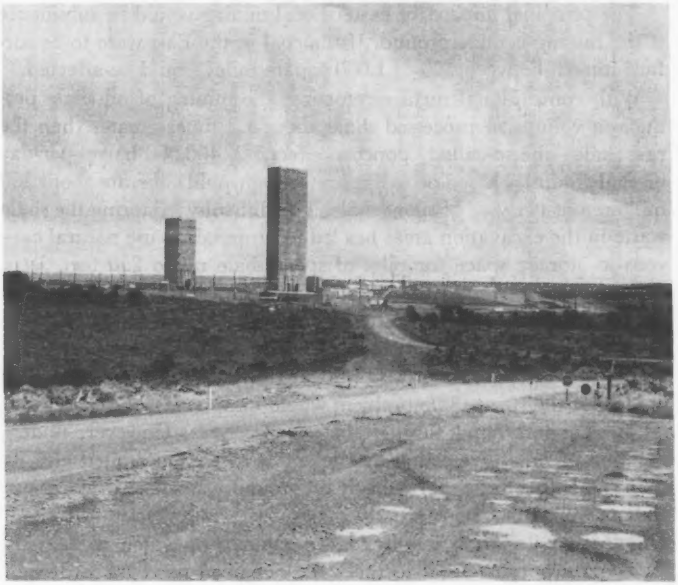
The principal impacts of eastern coal mining would be subsidence if the mining is underground. If the coal in the East were to be surface mined, between 300 to 1,000 square miles would be affected.

With conventional surface retorting, the mining of oil shale produces a volume of processed shale about 1.2 times greater than the raw shale—the so-called "popcorn effect." A 400,000 barrel-per-day oil shale industry based on surface retorting would generate about 200 million tons per year of spent shale. The difficulty in storing the shale waste in the excavation areas has led to proposals to use natural canyons as storage space for piles of spent shale up to 250 feet deep. Canyon storage would probably lead to the permanent loss of some canyon lands and to the destruction of natural wildlife habitats as well. The long-term stability of spent shale is uncertain and revegetation of spent shale has not yet been convincingly demonstrated.

Most of the spent shale problem would disappear if the shale were retorted underground through *in situ* processes. However, understanding of *in situ* retorting technology is still quite limited and its environmental effects, particularly on ground water, are problematic and not well understood.

Synfuels production requires large volumes of water, principally for cooling purposes and to meet the chemical need for hydrogen

An experimental oil shale plant in western Colorado, shown above, operated from 1964 to 1972, producing 180,000 barrels of shale oil in a surface retort. The plant shown below, also in Colorado, will use the in situ process, in which the shale is fractured and set afire underground. Photographer: James J. MacKenzie.



in the conversion process. Water may also be needed to quench gaseous products, to remove oil and particulates, to suppress dust, to help reclaim land, and to assist in disposal of solid waste. A 1.25 million barrel-per-day coal conversion program could require up to 180,000 acre-feet per year of water in the West for operation of the plants and another 8,000 acre-feet per year for mining the coal. In oil shale processing, water is chemically consumed in the generation of hydrogen for reactions with the raw shale; still larger quantities are consumed in mining and disposing of the shale. A 400,000 barrel-per-day oil shale operation would require 57,000 acre-feet per year. The total water consumption of the synfuel industry outlined here would be enough to irrigate roughly 100,000 acres of agricultural land per year. This much water may be physically available to appropriate locations in the West, but it may already be committed to farm or ranch use or claimed for other purposes. In addition to the water consumed in the synfuels plants, new towns to house plantworkers—over a thousand per plant for the 5 to 6 years necessary for construction—will put a further pressure on water supplies.

Finally, the long-term risks posed by the buildup of the carbon dioxide released in the burning of all fossil fuel should be noted. Many scientists believe that rising carbon dioxide levels will alter the earth's climate significantly, with possible adverse effects on agriculture and coastal settlements. The burning of all fossil fuels contributes to carbon dioxide buildup. Although synthetic gas and oil derived from coal add more carbon per unit of thermal energy generated to the atmosphere than conventional fossil fuels (between 1.2 and 2.8 times as much per unit), it is the overall use of all fossil fuels that contribute most of the additional CO_2 to the atmosphere. Worldwide use of all fossil fuels, including coal-based synthetic fuels, may have to be curbed if present concerns about the impact of carbon dioxide are confirmed.[50]

The primary concern with increased carbon dioxide emissions centers around the so-called "greenhouse" effect—the trapping of outgoing infrared radiation from the earth's surface. It is believed that the buildup of carbon dioxide could eventually cause a warming of the earth's surface. Although the exact amount of warming produced by a given carbon dioxide concentration is uncertain, it is the alteration in the global air circulation pattern associated with atmospheric warming that is of primary concern. Such alterations could lead, for example, to disruptions in agriculture.

A report from four environmental scientists prepared jointly and sent to CEQ stated their concern over the carbon dioxide issue in these terms:

> The CO_2 problem is one of the most important contemporary environmental problems, is a direct product of industrialization, threatens the stability of climates worldwide

> and therefore the stability of all nations, and can be controlled. Steps toward control are necessary now and should be a part of the national policy in management of sources of energy . . .
>
> The first element of any policy that offers the hope of being effective is conservation . . . All actions of government should be reviewed to determine effects on the total use of carbon-based fuels.[51]

Careful siting of synfuels plants and strict adherence to pollution control standards, some of which have not been developed, would mitigate adverse environmental consequences. Much additional research and development is necessary to determine the toxicity and/or carcinogenicity of many of the air and water pollutants, as well as to determine the optimal pollution control and siting strategies for the various facilities and activities involved.

The President has stated his commitment to requiring strict adherence to current and future environmental standards and to pursuing aggressive environmental research and development activities in parallel with the development of synthetic fuels. The Department of Energy has established a long-term comprehensive program to develop the ability to predict the environmental, economic, social, and political impacts of increasing atmospheric concentrations of carbon dioxide, as a basis for strategic policy decisions on the future global use of fossil fuels. The first assessment report of this program is scheduled for completion in 1984. Additional interagency efforts on the CO_2 question are also planned.

SOLAR ENERGY

With higher prices for conventional energy sources and steady technical progress in solar technologies, interest in the rapid development and installation of renewable energy sources has continued to increase.[52]

On June 20, 1979, President Carter delivered to the Congress the nation's first Presidential message on solar energy. The President outlined the major elements of a national solar strategy designed to accelerate the introduction of a broad range of renewable energy technologies. The President called for a combined effort by the federal government, state and local governments, industry, and private citizens, to achieve a national goal of meeting 20 percent of our energy needs with solar and renewable resources by the end of the century.

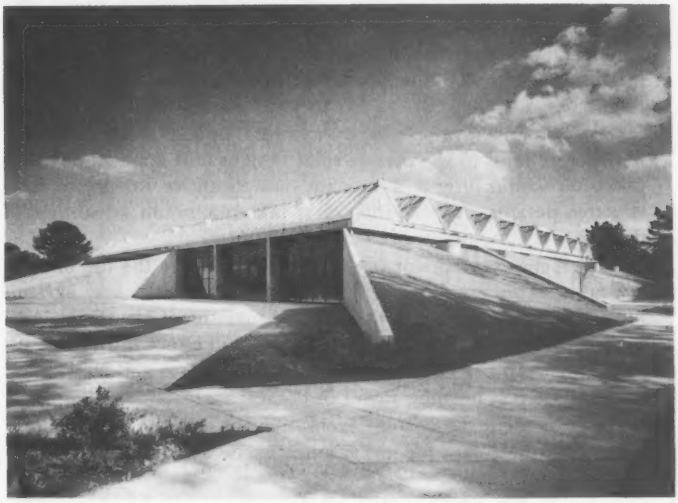
The Solar Message culmir ated a year-long governmentwide Domestic Policy Review (DPR) that the President initiated on Sun Day, May 3, 1978. The purpose of the solar DPR was to determine how best to marshal the tools of the government to advance the time when solar and renewable sources of energy become our primary energy resources.

The review concluded that a significant potential exists for expanding the nation's use of renewable energy resources. It estimated that a national program of comprehensive and aggressive initiatives could lead to a solar contribution of about 20 percent of national energy needs by the year 2000. Renewable resources now meet about 6 percent of national needs, principally through hydrodams and wood burning. The DPR also reviewed federal solar programs to see how they might be improved and developed program initiatives that could further accelerate the use of solar energy.

The DPR found that solar sources offer numerous advantages over competing technologies. Solar applications pose few environmental risks, offer a hedge against inflation, and provide diversity and flexibility in meeting our needs. Although many solar applications are already cost-effective, such as passive solar designs in buildings, low-head hydro, and direct wood burning, others will become economic with further research, demonstration, market development, and with the removal or reduction of subsidies to competing fuels.

The review group concluded that the introduction of renewable sources is presently hindered by widespread subsidies to conventional energy sources at both the federal and state levels. These include federal price controls, average cost rather than marginal cost pricing in state utility regulation, and a failure of the marketplace to reflect full social benefits and costs of various energy sources, e.g., relatively low air and water pollution from solar sources.

During the past year a number of important steps have been taken to help overcome these barriers. Gradual decontrol of oil and gas



The Shenandoah Solar Recreation Center, Shenandoah, Ga., won an award for outstanding architectural design. Photographer: Garbiel Benzur.

prices will help solar and renewable resource technologies compete, as the prices of oil and natural gas begin to reflect more closely their real market value.

Over the past 2 years, the federal financial commitment to developing and commercializing renewable energy technologies has been significantly increased. Federal expenditures, which were at a level of $358 million in fiscal year 1978, will rise to over $1 billion in fiscal year 1980. These funds will provide resources for a wide range of activities including:

- Tax credits and other assistance to encourage use of currently available solar and renewable resource technologies in homes and commercial buildings.
- Dissemination of information and training courses for users and installers of solar energy.
- Tax credits and other incentives for accelerated application of solar technologies in the agricultural and industrial sectors.
- A federal research and development program administered by the Department of Energy and funded at $646 million for fiscal year 1980. Major emphasis is being placed on photovoltaics, wind energy systems, biomass conversion, process heat, advanced passive design, and pursuit of solar thermal and ocean thermal systems.

In addition to the establishment of a national solar goal, the major elements of the President's solar program are:

- Creation of a Solar Bank to provide up to $1.1 billion worth of subsidies through fiscal year 1984 for owners and builders of residential and commercial structures who install solar equipment. The Solar Bank, through payments to financial institutions, would provide subsidized below-market rate loans for solar construction, both active and passive. It is estimated that up to 100,000 new and retrofitted solar units would be financed through the Solar Bank during the first year.
- Offer a 20 percent tax credit, up to a total of $2,000 per home, for new homes built to use passive solar designs and applications; this provision would offer a significant new incentive for use of cost-effective designs and materials that take maximum advantage of the direct heating power of the sun;
- Provide a new investment tax credit to encourage the use of solar technologies in providing process heat for industry and agriculture; this credit, added to the existing investment tax credit, provides a total of 25 percent and will remain in effect through 1989;
- Offer a new 15 percent tax credit for the purchase and installation of airtight wood burning stoves in homes; and
- Make permanent the current exemption for gasoline/alcohol mixtures from the 4-cent federal gasoline excise tax, to encourage the use of gasohol.

The President also established a permanent subcommittee of the Energy Coordinating Committee to monitor and direct the imple-

mentation of all of the solar programs across the government. The subcommittee will report regularly to the Energy Coordinating Committee, which is chaired by the Secretary of Energy and is composed of representatives of all major agencies of government with responsibility for solar and renewable applications.

In addition to the Administration's proposals, a number of other solar-related bills were introduced into the Congress. These included measures to subsidize the installation of solar systems by veterans, to establish youth employment and training programs in the fields of solar energy and energy conservation, to require the Department of Defense to install solar systems in all new family housing where it is cost effective, and to establish a 7-year $1 billion accelerated wind program.

NUCLEAR

Nuclear Energy Status and Projections

As of March 31, 1979, 70 nuclear power plants with a combined generating capacity of 51,000 megawatts electrical (MWe) were licensed to operate in the United States on 48 sites in 37 of the 48 contiguous states.[54] Together they supply about 13 percent of the nation's electrical power and about 4 percent of total U.S. energy use. An additional 96 units representing 101,000 MWe were under construction or authorized. Since October 1978, utilities have announced slowdowns in construction or have cancelled plans for 35 nuclear plants: 7 because demands for electricity continue to be lower than expected a few years ago, 9 for financial reasons, and 9 because of construction difficulties.[55]

Three Mile Island Accident

The most serious accident in the history of U.S. nuclear power began in the early morning hours of March 28, 1979. A chain of what was thought to be highly improbable events, involving both mechanical failure and human error, led to the release of a considerable amount of radioactivity and the evacuation of preschool children and pregnant women within 5 miles of the plant.

The accident occurred at Unit Two of the Three Mile Island nuclear power plant located near Middletown, Pa. Although a fully satisfactory description will require months of intensive analysis, it appears that the accident was initially triggered by the failure of a valve and the subsequent shutting down of a pump supplying feedwater to a steam generator. This in turn led to a "turbine trip" and a "scram," or shutdown of the reactor. These events in themselves should not have caused a problem, because all nuclear power plants are designed with backup systems that anticipate such failures. In this case, however, a number of additional factors quickly led to severe difficulties. These included: a pressure relief valve that failed to close, leading to a loss of substantial amounts of reactor coolant

into a quench tank; auxiliary feedwater pumps that were nonoperational because of closed valves, in violation of Nuclear Regulatory Commission (NRC) regulations; operator failure to respond promptly to the stuck relief valve; faulty readings on control room instruments, which led the operators to turn off the pumps for the emergency core cooling system; and operator shutdown of cooling pumps more than an hour after the accident began.[56]

Two days after the initial problems, a large bubble of radioactive gas (including potentially explosive hydrogen) was believed to have formed in the top of the reactor. Because of the potential of an explosion, the "bubble" posed what appeared to be the most serious threat to intensive NRC and company efforts to cool down the reactor. After several anxious days, during which a widespread evacuation of the area was considered, the bubble diminished in size and the potential for a major disaster faded. The gas was slowly dissolved into the coolant water and released into the containment structure.[57]

Part way through the accident, the President visited the facility. A few days later, he announced the establishment of the President's Commision on the Accident at Three Mile Island to be headed by John G. Kemeny, President of Dartmouth College. The Commission is conducting a comprehensive study and investigation of the accident, including: a technical assessment of the events and their causes; an analysis of the role of the managing utility; an assessment of the procedures and response of the NRC and other authorities; and an assessment of how the public's right to information was served. A final report that will include recommendations is scheduled for completion by October 1979.[58]

The accident raises a number of critical issues that are expected to be addressed by the Commission. Are NRC safety regulations adequate? Do utilities have the technical expertise needed to deal with serious, complicated, and unforeseen accidents? What should be done to insure that NRC regulations are strictly followed? Who is responsible for managing the crisis in the event of a serious accident? Are evacuation plans and procedures adequate? Who should sustain the financial losses associated with a major accident?

Public protest against nuclear power was expressed in a demonstration in Washington, D.C. on May 6, 1979, which was the largest demonstration against nuclear power. About 75,000 people marched from the White House to the steps of the Capitol, where Ralph Nader, Barry Commoner, and others called for a moratorium on nuclear power development. Organizers of the protest met the following day with President Carter. The President ruled out the possibility of shutting down all operating plants because of the dislocations that would be created. At the same time he stressed the need for making nuclear plants as safe as possible and for minimizing our dependence on them through conservation and the use of alternative energy sources.

Three Mile Island.

Nuclear Plant Shutdown

On March 13, 1979, the NRC ordered the shutdown of five operating nuclear plants to determine whether it is necessary to modify piping and piping support systems to bring them up to standard for withstanding earthquakes.[59] A computer error led to the difficulty. The design of all five plants was based on a computer model that did not correctly calculate the seismic forces the pipe systems must withstand in case of earthquake.[60]

Two of the plants, in Pennsylvania and Virginia, were already shut down for other reasons at the time of the order. The other three, in Maine, New York, and Virginia, were to remain closed until the need for modifications could be determined.[61] By July 1979 one of these plants had been returned to operation.

Reactor Safety Study Review

The Three Mile Island accident raised questions about nuclear reactor safety in a very immediate way. Meanwhile, the Nuclear Regulatory Commission had already taken a second look at the Reactor Safety Study (The Rasmussen Report), a comprehensive and generalized study of reactor safety issued by the Commission 4 years ago. The report had been widely quoted as concluding that the risk to the general population from light water reactor nuclear power plants was negligible—less than the risk of being struck by a meteor. After a special review of the report, the NRC issued a policy statement that was critical of both the substance of the final report and the treatment of comments on the draft from other scientists.[62]

The NRC announced that it was withdrawing any explicit or implicit past endorsements of the executive summary of the report and said it accepted the review group's conclusion that absolute values of the risks presented in the report should not be used uncritically, either in the regulatory process or for public policy purposes. The review group concluded that the methods used in the report did not yield valid conclusions on accident probabilities. The NRC consequently emphasized that it did not regard as reliable the report's numerical estimates of the overall risks of a reactor accident.[63] The NRC added, however, that it expects its staff to make use of parts of the Reactor Safety Study as appropriate, "that is, where the data base is adequate and analytical techniques permit."

The review group was chaired by Professor Harold Lewis of the University of California at Santa Barbara. It was created in response to concerns of Congressman Morris K. Udall and others who expressed misgivings about the report and its executive summary.[64]

Clinch River Breeder Reactor

In May 1979, President Carter reaffirmed his opposition to the construction of the Clinch River Breeder Reactor (CRBR) project. He reiterated his determination to cancel the project and to defer, for the present, commercial development of breeder reactors that rely in their fuel cycles on the recycling of plutonium or other nuclear material that could be used for the manufacturing of weapons. The President also referred in his announcement to the uneconomic and obsolete technical design of the CRBR plant. He committed the Administration to a study of alternative reactor designs, calling for more modern, economic, and safe breeder reactor components and fuel cycles. The study will be completed in time for a decision by March 31, 1981, on whether to undertake a large breeder reactor project.[65]

The President also noted that the present U.S. uranium reserves are more than adequate to meet all our nuclear fuel needs until at least the year 2020 and probably well beyond. He called for research and development of the breeder as only one of a number of long-range energy options.[66]

The light water reactor, the most common type in operation or under construction in the world today, is fueled with low (2 to 3 percent) enriched uranium fuel that cannot be used to make bombs. In the once-through fuel cycle, which U.S. reactors presently use, spent fuel removed from the reactor is stored until cool, then disposed of permanently. Plutonium, which is one of the byproducts of fission in a light water reactor, is not reprocessed or used for fuel. The advantage of this once-through system is that it reduces the risk of nuclear proliferation. It may, however, be considered to add something to the problems of nuclear waste disposal, which are discussed below.

Interagency Review of Nuclear Waste Management

The Interagency Review Group on Nuclear Waste Management (IRG) made its final report to the President in March 1979.[67] The report concluded that the primary objective of nuclear waste management is that: "Existing and future nuclear waste from military and civilian activities (including discarded spent fuel from the once-through nuclear fuel cycle) should be isolated from the biosphere and pose no significant threat to public health and safety." [68]

Some other important findings of the IRG report were:

- The responsibility for establishing a waste program should not be deferred to future generations;
- A broader research and development program for waste disposal, particularly geologic isolation, should begin promptly; and
- Public participation should be developed and strengthened for all aspects of nuclear waste management programs.

The IRG considered that repositories mined in geologic formations would be available sooner than other options for disposal of nuclear waste. The wastes of most concern are the high-level and transuranic wastes, which contain materials with decay times ranging from hundreds to millions of years. The major conclusions on the status of knowledge of mined repositories were as follows:

- Overall scientific and technological knowledge is adequate to proceed with region selection and site characterization, despite the limitations in our current knowledge and modeling capability;
- A systems approach should be used to select the geologic environment, respository site, and wasteform;
- Detailed studies of specific potential repository sites in different geologic environments should begin immediately;
- The radioactivity from long-lived actinide elements in both transuranic and high-level wastes suggest that both waste types present problems of comparable magnitude for the very long term (i.e., longer than a thousand years);
- The degree of long-term isolation provided by a repository, viewed as a system, and the effects of changes in repository design, geology, climate, and human activities on the public health and safety can only be assessed through analytical modeling; and
- The effects of future human activity must be evaluated more carefully.

The 14-member IRG made its report after a year-long review. A draft report issued in October drew an unprecedented 3,300 written comments, which were considered by the group and summarized in the final report. The draft report's findings on the present state of scientific and technical knowledge drew particularly heavy comment; the final report modified these findings in the direction of a greater recognition of uncertainties.

The final report states: "Present scientific and technological knowledge is adequate to identify potential repository sites for fur-

ther investigation. No scientific or technical reason is known that would prevent identifying a site that is suitable for a repository provided that a systems view is utilized rigorously to evaluate the suitability of sites and designs, and in minimizing the influence of future human activities." [69] A suitable repository site is one that would meet predetermined criteria and would provide a high degree of assurance that radioactive waste can be successfully isolated from the biosphere for thousands of years.

The report recognized that for periods beyond a few thousand years, our capability to assess the performance of the repository diminishes. The feasibilty of safely disposing of high-level waste in mined repositories can only be assessed on the basis of specific investigations at particular sites and determinations of their suitability. Information obtained at each successive step of site selection and repository development will permit reevaluation of risks, uncertainties, and the ability of the site and repository to meet regulatory standards. Such reevaluations would lead to abandonment of the site or to a decision to proceed to the next step.

"Reliance on conservative engineering practices and multiple independent barriers can reduce some risks and compensate for some uncertainties," the report said. "However, even at the time of decommissioning, some uncertainty about repository performance will still exist. Thus, in addition to technical evaluation, a societal judgment that considers the level of risk and the associated uncertainty will be necessary." [70]

While agreeing with the statement outlined above on the state of scientific and technical knowledge on mined repositories, some members of the IRG were still concerned that insufficient attention is given in the report to significant gaps and uncertainties in our current technical understanding. The scientific feasibility of the mined repository concept remains to be established. The preferred approach to long-term nuclear waste disposal may prove difficult to implement in practice and may involve residual risks for future generations that may be significant.

The IRG compared the status of knowledge relevant to disposal in mined repositories with such other technical options as placement in deep ocean sediments, placement in very deep drill holes, placement in a mined cavity in a manner that leads to rock melting, partitioning of reprocessing waste and transmutation of transuranic elements, and ejection into space. It concluded that near-term program activities should be predicated on the tentative assumption, made for interim planning purposes, that the first disposal facilities will be mined repositories. The group recommended that the nearer-term alternatives (that is, deep ocean sediments and very deep holes) should be given funding support so that they may be adequately evaluated as potential competitors. Funding of other concepts should allow some feasibility and preliminary design work to proceed. Once an environ-

mental impact statement on the waste disposal program is completed, policymakers will have a better basis on which to allocate funds among alternatives.

Other important conclusions of the report concerning high-level wastes include the following:

- Near-term research and development and site characterization programs should be designed to provide, at the earliest date feasible, a choice of sites with a variety of potential host rock and geohydrological characteristics. To accomplish this, research and development on several potential emplacement media and site characterization work on a variety of geologic environments should be increased promptly.
- After a number of potential sites in a variety of geologic environments are identified, the option to use them if needed at an appropriate time should be reserved. Instead of working toward a single national repository, the near-term program should create the option to have at least two (and possibly three) repositories become operational within this century, ideally in different regions of the country. In pursuing a regional approach to siting, geologic, hydrologic, tectonic, and other technical characteristics of sites and safety considerations must remain the primary basis for selection.
- Construction and operation of a repository should proceed on a stepwise basis and initial emplacement of waste, in at least the first repository, should be planned to proceed on a technically conservative basis and should allow retrieval of the waste for some initial period of time. Further definition of the retrievability concept, the circumstances in which waste would be retrieved and the technical aspects (including development of waste packaging, containers and handling), is necessary.
- Interim storage of spent fuel is needed for the present, until disposal facilities are available; in addition, interim storage has the advantage of reducing the heat burden before disposal. To the maximum extent possible, utilities should keep their spent fuel at reactors until a repository is available. However, some spent fuel will have to be moved since capacity at some reactors is limited. Interim storage capacity can also provide more time and greater flexibility in selecting repository sites and bringing repositories into operation. For these reasons, the federal government should provide a limited storage capacity, with costs to be paid by the utilities.
- Reprocessing is not required to assure safe disposal of commercial spent fuel in appropriately chosen geologic environments. Moreover, current U.S. repository designs are based on the ability to receive either solidified reprocessing waste or discarded spent fuel.

IRG recommended that DOE accelerate its research and development for improving immobilization and waste forms and review its current immobilization programs in the light of the latest scientific

and technical views. Because final processing of defense waste has been deferred for 3 decades IRG also recommends that remedial action, including immobilization of the waste, should begin as soon as practicable.

IRG also considered some problems of low-level waste disposal, and recommended that in the future much greater attention should be given to the hydrologic characteristics of proposed locations for disposal facilities than has been the case in the past. IRG also recommended that by 1981, DOE and NRC should review existing and alternative lower-level waste disposal techniques.

Uranium Mill Tailings The IRG considered the safe disposal of mill tailings a matter of great urgency and importance. About 10 to 15 million tons of uranium mill tailings are generated each year. They are hazardous because they contain long-lived radon and radium—which will diminish by only one-half in roughly 80,000 years—and because they have been left in waste piles where humans may come into contact with them. IRG did not conduct a detailed technical evaluation of mill tailing problems or of approaches to their solution because such an evaluation is underway by NRC for its Draft Generic Environmental Impact Statement. IRG restricted itself to general policy guidelines including three central components:

- Completion of regulations by NRC and EPA on acceptable levels of radon emissions, siting (to reduce the possibility of human exposure and provide for long-term isolation), impacts on ground water, and methods of ultimate disposal;
- Issuing standards for abandoned sites, and taking remedial action at selected sites; and
- Developing improved technology for disposal of tailings.

Waste Generated By Decontamination and Decommissioning Nuclear power reactors, other nuclear facilities, and some waste disposal sites will eventually reach the end of their useful lives and will have to be decontaminated and decommissioned (D and D operations). There are currently no standards to guide such actions nor is there agreement on the best techniques and procedures. The nuclear waste resulting from D and D operations will be voluminous, but not unique, and would be handled identically to equivalent waste types from other sources.

As a general rule, unrestricted use of land should be the ultimate objective of D and D; after a time, institutional controls should not be necessary to protect people and the environment. However, in certain exceptional existing sites, facilities cannot be decontaminated at a reasonable cost, or perhaps at any cost; here, long-term institutional control may be necessary, and will be developed case-by-case by NRC or DOE.

Until it is safe to resume unrestricted use, there will have to be site controls, monitoring and surveillance, and effective recordkeeping at the site of decommissioned facilities. None of these exist yet.

Funds for long-term care, guarantees, and contingencies are also needed. Providing for these management needs will take new legislation.

Institutional Problems In IRG's view, dealing with institutional issues in a nuclear waste management program is as important and difficult as technical problems—perhaps more so.

Significant institutional difficulties are involved in: marshalling the resources needed to detail criteria for site suitability and to establish standards; thorough investigation of possible sites; accurate assessment of site characteristics in light of the criteria; analysis of risks; obtaining agreement on site selection; getting the facility approved and licensed; providing for careful construction and operation of the repository (including safe transportation and handling of the wastes); mitigating accidents and coping with repository failure if that occurs; and providing adequate, long-term monitoring. All these problems could increase in difficulty with the size of the nuclear waste inventory and its rate of growth. Institutions that can cope on a small scale may fail as the demands placed on them multiply. According to IRG, a more detailed analysis of logistical and other institutional problems of nuclear waste management on the required national scale should be undertaken.

Siting There has been growing concern over states' acceptance of nuclear repository sites. Proposals have included, on the one hand, federal supremacy for located waste repository sites and on the other, authority for states to veto federally proposed nuclear waste repository sites within their borders. The National Governors' Association and the National Conference of State Legislatures have proposed a federal/state process of "cooperative federalism" or "consultation and concurrence." Under this approach, the states would be involved in planning and in reviewing early site characterizations and in selecting potential sites, concurring with each step in the process before the next activity begins. IRG recommended the "consultation and concurrence" approach.

Public Participation IRG urged that waste management decisions be made only after open debate in which information is available and varying points of view are represented. Advice should be sought from expert federal agencies such as the U.S. Geological Survey, professional scientific and engineering societies, review groups such as the National Academy of Sciences, scientists and engineers or their organizations, the utilities, and others in private business, public interest groups, and individual citizens. IRG recommended that agencies with responsibilities for waste management strengthen mechanisms for receiving such advice.

Uranium Resources

In March the Department of Energy testified to the Congress that DOE's latest domestic uranium resource survey shows that sufficient uranium would be available to supply conventional nuclear reactors

through the year 2040, even if nuclear capacity increases eight-fold by the year 2000.[71]

Estimates on when uranium supplies run low are a key factor in determining long range energy research and development policy, particularly for the possible use of breeder reactors and the need for reprocessing spent nuclear fuel.

In announcing its recently revised estimates, DOE noted that 2.4 million tons is enough fuel for 421 reactors of the 1,000 MWe (1 gigawatt) size for the 30-year lifetimes. DOE also noted that its current estimates for total installed nuclear capacity will be less than 200 gigawatt by the year 2000.[72]

Nuclear Non-Proliferation

In April 1979, President Carter submitted to Congress the first annual report required under Section 601 of the Nuclear Non-Proliferation Act of 1978.[73] The President listed several successes and obstacles the United States has encountered in its first year of changing nuclear diplomacy. Among the successes was the agreement by most countries to use newly developed high-density fuels of low enrichment for research reactors, instead of the highly enriched fuel now in use that can be used directly to fabricate nuclear weapons.[74]

INTERNATIONAL ENERGY SUPPLY

Troubles in Iran The revolution in Iran that led to a 68-day shutdown of that country's crude oil production underscored the continuing vulnerability of U.S. energy supply to external disruption. Until the shutdown on December 1978, Iran had provided about 11 percent of the oil supply for non-Communist countries. The loss of production brought on worldwide increases in crude prices, contributed to tight supply and shortages of gasoline in the United States, and demonstrated once again the need for diversified sources of supply, improvements in energy productivity, and alternative energy sources.[75]

World Supplies Tighten In response to the loss of Iranian oil, other producing countries—principally Saudi Arabia, Kuwait, Nigeria, and Venezuela—increased their oil production; collectively they made up 3 to 4 million barrels per day (mmb/d) of the loss.[76] The shortfall to the non-Communist world's supplies was therefore not 11 percent, but about 4 percent.

Before the December cutoff, the United States was importing either directly or through Caribbean refineries about 800 thousand barrels a day from Iran. Net losses, taking into account the increased production from other suppliers, were estimated at about 400 to 500 thousand barrels per day, or about 3 percent of U.S. oil demand.[77] The impacts on other importing nations varied considerably, depending on their sources of supply. Countries heavily dependent on Iran for oil during 1978 included Spain (27 percent of its supply); Bel-

gium, New Zealand, and the Netherlands (all more than 20 percent); and Japan (17 percent).[78]

In early March, the United States and 19 other members of the International Energy Agency agreed to cut 1979 oil consumption by 5 percent, or about 2 million barrels per day.[79] In the meantime, Iran resumed oil production in mid-March, and gradually increased production to more than 4 million barrels per day by mid-April.[80] In late March, OPEC raised its prices for crude oil from $13.34 to $14.55 per barrel. On April 15, Iran announced an additional 13 percent surcharge to $16.57 per barrel.[81] In mid-1979, OPEC prices were further increased to $18.00 to $23.50 per barrel level.

In response to the Iranian problem, President Carter announced several new actions in his April 1979 Energy Message. Among these were curtailment and conservation measures. The first are short-term actions to ease present day-to-day supply problems, and the second long-term measures to slow the future growth in energy demand. The short-term curtailment measures were the Administration's response to the loss of Iranian oil and were intended to help meet the U.S. commitment to the International Energy Agency to reduce expected oil consumption by 5 percent.

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CHAPTER 6

NATURAL RESOURCES

Two of the nation's most valuable natural resources—fresh water and agriculturally productive soil—are in need of better conservation and management. *The Second National Water Assessment* of the U.S. Water Resources Council (WRC) found shortages of surface water in several regions of the country, as well as overdrafts of ground water—resulting in declining water tables—in parts of the High Plains, Arizona, and California. The WRC report concluded that there is a special need for better water conservation and management, particularly in irrigated areas of the West.

Despite more than 40 years of soil conservation efforts, the nation's agricultural soils are still being eroded by wind and water at unacceptable rates; meanwhile, some of our most productive farm lands are being converted to other uses, primarily residential and commercial development. Secretary of Agriculture Bob Bergland and Council on Environmental Quality (CEQ) Chairman Charles Warren have initiated a new interagency study that will analyze the factors affecting the availability of land for agricultural use and make recommendations by January 1981 for consideration by federal, state, and local government agencies.

Although serious problems remain, there was progress in managing the nation's natural resources during the past year. President Carter's veto of a bill funding some two dozen economically and environmentally unsound water dam and diversion projects was upheld. The Administration initiated several significant changes in federal water resources programs and introduced legislative reform proposals.

A number of valuable wilderness resources moved closer to permanent protection. Eight new river segments were added to the Wild and Scenic Rivers system. The U.S. Forest Service completed its review of 62 million acres of roadless land under its jurisdiction (an area approximately the size of the state of Wyoming) and recommended that 15 million of those acres be given official wilderness status. The U.S. Department of the Interior's Bureau of Land Management has begun a review of 61 million acres of public lands with wilderness potential under its jurisdiction.

The fate of vast amounts of federally-owned land in Alaska was, as of mid-1979, still pending before Congress. However, a bill plac-

ing approximately 125 million acres of these public lands—one third of acreage of the state—under one or another of the major federal land protection systems (National Forests, National Parks, Wildlife Refuges, and the Wild and Scenic Rivers System) had passed the House of Representatives by a wide margin.

WATER RESOURCES

THE NATIONAL WATER ASSESSMENT

Although the United States as a whole has ample surface and underground water resources, the uneven distribution of these resources has produced some serious local and regional water shortages. Such shortages are generally associated with the arid West, but they have occurred at various times in other parts of the nation as well. Water shortages generally reflect inadequate surface and ground water sources, especially where water is intensively used to satisfy multiple demands such as irrigated agriculture, municipal and industrial supplies, energy production, recreation, and maintenance of fish and wildlife habitat. But shortages of usable water can also be caused by poor water quality.

These are some of the principal findings of the *Second National Water Assessment,* released in December 1978 by the WRC.[1] The WRC is composed of seven cabinet secretaries and the Administrator of the U.S. Environmental Protection Agency (EPA). One of its duties is to maintain a continuing study of the nation's water and related land resources and to assess periodically the adequacy of these resources to meet present and future water requirements. The *Assessment* was a multiyear effort that included both nationwide and regional analyses based on data compiled from each of the 106 watershed subregions of the United States, which were aggregated into 21 water resources regions corresponding to the nation's major surface water drainage basins (see Figure 6–1).

Water use can be either "in stream," for purposes such as hydroelectric power generation, recreation, and aquatic wildlife habitat, or "off stream," for agricultural, industrial, and domestic purposes. When water is withdrawn from surface or underground sources and not returned after use (i.e., lost through evaporation, transpiration, or other processes), such a use is classified as *consumptive.* As Table 6–1 indicates, although WRC projections indicate a decline in total fresh water withdrawals between now and the year 2000, a significant increase in consumptive use is projected for the same period.

In part because of this projected increase in consumptive use, the *National Water Assessment* highlighted a number of critical water resource problems in need of attention by all levels of government. Among these problems are:

- Inadequate surface water supply—Although local water supply problems were identified in all 21 regions, 17 of the 106 sub-

regions in the Midwest and far West have now or will have serious surface water problems by the year 2000 (see Figure 6–1).

- Overdraft of ground water—Serious ground water overdrafts, resulting in declining water tables, are occurring in the High Plains area and in parts of Arizona and California (see Figure 6–2).
- Pollution of surface and ground water—Surface and ground water pollution were reported in most of the 21 regions. Maintenance of both surface and ground water quality for drinking is of concern nationwide, but especially in rural areas where drinking water receives little or no treatment.

Figure 6–1

Areas of Inadequate Surface Water Supply

Explanation
Subregion with inadequate streamflow ("1975"-2000)
70 percent depleted in average year
70 percent depleted in dry year
Less than 70 percent depleted
Specific problems as identified by Federal and State/Regional study teams
Conflict between offstream and instream uses
Inadequate supply of fresh surface water to support—
Offstream use
Central (municipal) and noncentral (rural) domestic use
Industrty or energy resource development
Crop irrigation
Instream use
Fish and wildlife habitat or outdoor recreation
Hydroelectric generation or navigation
Boundaries
Water resources region
Subregion

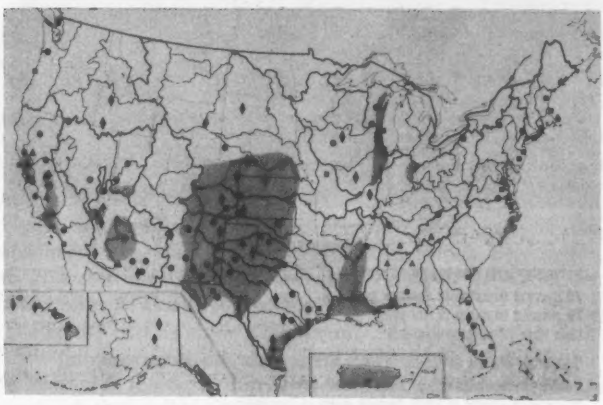
Source: U.S. Water Resources Council, *Second National Water Assessment,* 1978, Vol. 1, p. 57.

- Flooding—In 1975, the data base year for the assessment, 107 persons were killed by flood waters and property damage was estimated at $3.4 billion. The WRC report estimates that such damage will increase to $4.3 billion annually by the year 2000 unless there is increased flood plain management and control of unwise flood plain development.
- Erosion and sedimentation—For the 1975 base year, average cropland soil losses were nearly 9 tons per acre; in some areas soil losses ranged from 25 to more than 100 tons per acre. Forest and pasture lands also sustained average soil losses of about 1 ton per year.

The water quality and soil erosion problems highlighted above are discussed further in other sections of this report. Some specific examples of water supply and related land use problems are discussed below.

Figure 6–2

Areas and Specific Locations of Ground Water Overdraft Problems



Explanation

- Area in which significant ground-water overdraft is occurring
- Unshaded area may not be problem-free, but the problem was not considered major

Specific problems as identified by Federal and State/Regional study teams

- Declining ground-water levels
- Diminished springflow and streamflow
- Formation of fissures and subsidence
- Saline-water intrusion into freshwater aquifers

Boundaries

- Water resources region
- Subregion

Source: U.S. Water Resources Council, *Second National Water Assessment*, 1978, Vol. 1, p. 59.

Table 6–1

Total Withdrawals and Consumption, by Functional Use, for the 21 Water Resources Regions, 1975,[a] 1985, 2000

(million gallons per day)

Functional Use	Total Withdrawals			Total Consumption		
	1975 [a]	1985	2000	1975 [a]	1985	2000
Fresh water:						
Domestic:						
Central (municipal)	21,164	23,983	27,918	4,976	5,665	6,638
Noncentral (rural)	2,092	2,320	2,400	1,292	1,408	1,436
Commercial	5,530	6,048	6,732	1,109	1,216	1,369
Manufacturing	51,222	23,687	19,669	6,059	8,903	14,699
Agriculture:						
Irrigation	158,743	166,252	153,846	86,391	92,820	92,506
Livestock	1,912	2,233	2,551	1,912	2,233	2,551
Steam electric generation	88,916	94,858	79,492	1,419	4,062	10,541
Minerals industry	7,055	8,832	11,328	2,196	2,777	3,609
Public lands and others [b]	1,866	2,162	2,461	1,236	1,461	1,731
Total fresh water	338,500	330,375	306,397	106,590	120,545	135,080
Saline water,[c] total	59,737	91,236	118,815			
Total withdrawals	398,237	421,611	425,212			

[a] The base year 1975 represents assumed average conditions based on incomplete data.

[b] Includes water for fish hatcheries and miscellaneous uses.

[c] Saline water is used mainly for manufacturing and steam.

Source: U.S. Water Resources Council, *Second National Water Assessment*, December 1978, Vol. I, p. 48.

CRITICAL SURFACE WATER SUPPLY PROBLEMS

Once navigable for more than 200 miles inland from its mouth in the Gulf of California, the Colorado River has been so extensively dammed and diverted that it no longer reaches the sea, but ends up as a trickle, laden with sediment and salt, that finally disappears in the Mexican desert south of Yuma, Ariz.[2] Between its origins high in the Rocky Mountains of Colorado and Wyoming and its terminal point, the river's water is used to generate hydroelectric power for more than 200 utilities and co-ops, to irrigate 3.4 million acres of land, and to help provide municipal water supplies for more than 10 million people.[3]

Water shortages are particularly acute in the lower Colorado River basin. The water available to Arizona and California consists of (1) a portion of the main stem Colorado River water released at Glen Canyon Dam under provisions of the 1922 Colorado River Compact and operation agreements, (2) natural runoff from a few small tributaries, and (3) ground water.

Currently, surface water use exceeds available renewable supplies in this region. The difference is presently being obtained by over-

draft of the ground water supply in central Arizona and southern Nevada. In these areas, ground water levels are declining an average of 8 to 10 feet per year. Withdrawn water is used mainly for irrigation. If surface water withdrawals continue to increase, the river's average annual flow will be inadequate to meet the requirements of the 1922 Interstate Compact or the 1944 treaty with Mexico, which obligates the United States to maintain a specified minimum flow and quality of water into that country. More recent analyses indicate that these allocations were based on abnormally high flows.[4] To compensate, ground water supplies, already insufficient for present needs, will be further overdrawn.

CRITICAL GROUND WATER SUPPLY PROBLEMS

The ground waters of the United States are a vast resource estimated to have a volume far greater than all the surface water in the nation's streams, lakes, and reservoirs (including the Great Lakes). The total ground water within 2,500 feet of the surface is estimated to be at least 33 trillion gallons, an amount equivalent to that discharged by the Mississippi River during the past 200 years.[5] However, the amount of ground water actually accessible for domestic, municipal, and industrial uses is much less than this total, due to economic and environmental constraints. Furthermore, increasing demands are causing mounting stress on available water resources (see Figure 6–2). The discussion below focuses principally on ground water supply, or quantity problems; ground water quality issues are discussed in Chapter 2.

Many parts of the country are using ground water at rates exceeding natural recharge (i.e., the water is being mined). This practice has many undesirable effects. It causes problems with diminishing artesian pressure, declining spring and stream flow, land subsidence, and salt water intrusion. As long as the water remaining in storage underground is still relatively plentiful and accessible, mining the water is likely to continue. Yet these continued withdrawals without compensating recharge merely defer the inevitable day when alternative sources must be found or serious decisions must be made concerning the continued existence of water-dependent industries, irrigated agriculture, or residential communities. In the meantime, irreversible environmental damage may have occurred; for example, subsurface compaction and land subsidence may damage the aquifer to the extent that it will never fully recharge.

In some areas, declining water tables will cause abandonment of water-depleting activities before the water is totally consumed because of the increasing cost of the energy required to bring it to the surface. This has already begun in the Trans-Pecos areas of Texas. Decades of pumping for irrigation and, more recently, for homes and industries have produced severe and continuous declines in ground water levels in this area. Abandonment of large irrigated areas began

recently when prices for natural gas used to run the pumps made continued production uneconomical.

The interconnection between surface and ground waters is commonly overlooked, except perhaps where springs or smaller streams suddenly begin to go dry in the summer. About 30 percent of the nation's streamflow in an average year is water that has returned to the surface from underground natural springs and other seepage.[6] However, surface water drainage patterns may have little or no apparent relationship to these underlying aquifers, or ground water reservoirs. Thus, excessive ground water use in one area may result in surface water depletions in another. This problem occurs in the Upper Susquehanna River Basin in parts of Pennsylvania and New York, as well as in several Western river basins.[7]

The WRC report notes that when base flows in streams are reduced or eliminated, the result is "increased harm during critical low-flow periods to aquatic and wildlife habitats in streams, wetlands, coastal marshes, and estuaries." The report adds: "Often the precise location of a possible threat cannot be related to specific ground water pumping locations." [8]

This dry Colorado rangeland was put into corn production using a central pivot irrigation system. However, not enough water was available and the crop failed. Photographer: Jerry Schwien.

When pumping or other withdrawals cause ground water levels to drop substantially, land subsidence may follow. In such situations the elevation of the ground surface may fall several feet over a relatively large area. Coastal areas adjacent to San Francisco Bay [9] and along the Galveston Bay in Texas [10] have experienced periodic tidal flooding in areas that previously were at a higher elevation. Subsidence can also cause undulations and cracks in the surface. Buildings have been damaged,[11] and highways and railroads have developed alignment problems.[12]

One of the most serious possible consequences of subsidence is that the aquifer may become permanently compressed, and thereby lose much of its capability for water storage. Another problem is salt water intrusion. In the nation's coastal areas, fresh water aquifers discharge into or hold back adjacent underground salt water. In island areas, shallow fresh water "lenses" actually "float" on the more dense saltwater below. Reduction of pressure in these freshwater aquifers has allowed salt water to replace fresh, contaminating domestic wells and threatening existing development. This has occurred in south Florida, southeast Georgia, and other areas, as shown in Figure 6–2. Even in the interior of the United States, pockets of saline ground water sometimes underlie, or are connected to, fresh water aquifers. Overpumping in such areas may cause the saline water to migrate toward the wells.

Lack of information regarding the extent, volume, recharge rate, and cumulative effect of various pumping schemes often presents serious ground water management problems. Gathering and interpreting such information has largely been the responsibility of state and local governments.

Those areas essentially dependent on ground water sources for their economic base deserve special concern. For example, the WRC *National Water Assessment* points out that the High Plains of west Texas and eastern New Mexico contain the largest irrigable land mass in the world: 52 million acres, roughly equal to Kansas (the 14th largest state). Nearly 10 million acres presently irrigated in this region are threatened by continued removal of ground water in excess of recharge rates.[13] Much of our domestically produced cotton is grown on this land.

In the absence of an alternative source of water supply or effective water conservation measures, some irrigated lands now dependent on ground water mining will revert to dry land uses such as grazing. Farm income and production from such lands will decline drastically.

SOIL SALINIZATION

Although most of the San Joaquin Valley in central California averages less than 10 inches of rainfall per year, a massive irrigation system has transformed its 8 million acres into one of the richest

agricultural districts in the world, annually producing more than $4 billion in vegetables, fruits, cotton, and other crops.

But this intensive irrigation-based farming is also increasing the soil salinity on several hundred thousand acres. According to a recent federal-state study, some farmers have been forced to switch to salt-tolerant crops, and annual crop losses from saline soils now exceed $30 million per year.[14]

This problem is not restricted to the San Joaquin Valley: as noted in CEQ's 1978 Annual Report, it has occurred on irrigated lands thoughout the world.[15] All irrigation water contains some dissolved mineral salts, which are concentrated during use through evaporation and transpiration processes and the addition of fertilizers and pesticides. Unless these salts are removed by surface or underground drainage, they accumulate in the root zone and eventually render the soil useless for agriculture. In the San Joaquin Valley, subsurface layers of impermeable clay have trapped the saline irrigation water, forming a "perched" water table near the soil surface. The study suggests that a network of drains be constructed to transport this accumulated water nearly 300 miles to the Sacramento-San Joaquin delta at an estimated cost of $750 million, to be funded by the state and federal governments and repaid, at least in part, by the project beneficiaries. Critics of the proposal are concerned about its costs as well as the potential adverse environmental effects of discharging this chemical-rich water into the Suisun marsh near San Francisco.

FLOODPLAINS AND WETLANDS

Until recently, water resources planning and management efforts have focused almost exclusively on "permanent" water resources—such as rivers, streams, lakes, and ground water aquifers. During this decade, however, government agencies and the public have given increased attention to protecting the existing natural and economic value of lands periodically flooded or otherwise saturated by surface or ground water—floodplains and wetlands.

As discussed in previous annual reports,[16] unwise development in such areas has resulted in increasing loss of life and property and in reduction of uses compatible with periodic inundation, such as agriculture and forestry, recreation, and fish and wildlife habitat. In order to discourage federal support of unwise development in floodplains and wetlands, and to provide federal leadership in preserving and enhancing the beneficial use of such areas, President Carter issued Executive orders in May 1977 on floodplain management and wetland protection.[17]

Both orders directed federal agencies to issue or amend existing regulations and procedures to provide for compliance. The Water Resources Council issued formal guidelines in February 1978, to assist agencies in implementing the floodplain management Executive

order.[18] Agency draft procedures were reviewed for consistency and technical compliance by WRC, CEQ, and Federal Insurance Administration officials. Many agencies have been slow to publish floodplain management implementing procedures, however, despite a 1-year deadline incorporated in the Executive order. Agency implementing regulations or procedures published by June 30, 1979, are listed in Table 6–2.

Agencies' implementation of the wetlands protection Executive order is also incomplete; however, this is in part because the definition and identification of wetlands has presented some difficult scientific and technical questions. To assist federal and state agencies and other interested parties in understanding and coordinating wetland protection and floodplain management activities, the WRC conducted a series of seminars and workshops during 1979 and prepared a report on the results of these proceedings.[19] CEQ coordinated a related effort by several federal agencies to increase public awareness of wetlands and current wetland policies. The result was an illustrated interagency report entitled *Our Nation's Wetlands,* which CEQ released in July 1979.[20]

Flood damage on North Carolina coast. Federal agencies have been instructed to develop better floodplain management procedures.

Table 6–2

Status of Federal Agency Procedures Implementing Executive Order 11988, Floodplain Management, and Executive Order 11990, Wetlands, July 11, 1979

Federal Agency	Floodplain Regulations		Wetlands Regulations	
	Draft	Final	Draft	Final
Department of Agriculture	×			
Soil Conservation Service	×			
Rural Electrification Administration	×			
Economics, Statistics and Cooperative Service				
Farmers Home Administration [a]	×			
Forest Service				
Science and Education Administration				
Agricultural Stabilization and Conservation Service				
Department of Commerce [a]	×	×	×	×
Economic Development Administration [a]	×	×	×	×
National Oceanic and Atmospheric Administration				
Department of Defense (Construction)	×	×		
Air Force				
Army(Military) [a]				
Army Corps of Engineers (Civil Works)	×	×		
Navy [a]				
Department of Energy	×	×		
Federal Energy Regulatory Commission				
Department of Health, Education, and Welfare [a]				
Education Division				
Public Health Service				
Department of Housing and Urban Development [a]	×			
Community Development Corporation				
Federal Disaster Assistance Administration	×			
Federal Emergency Management Agency				
Community Planning and Development				
Housing Production and Mortgage Credit				
Housing Management				
Department of the Interior [a]	×	×		
Fish and Wildlife Service [a]	×			
Heritage Conservation and Recreation Service [a]	×	×		
National Park Service [a]	×			
Bureau of Land Management [a]	×	×		
Bureau of Reclamation [a]	×			
Bureau of Indian Affairs [a]				
Office of Surface Mining [a]				
Bureau of Mines [a]				
Geological Survey [a]				
Department of Justice [a]				
Bureau of Prisons [a]				
Law Enforcement Assistance Administration [a]				
Immigration and Naturalization Service [a]				
Department of Labor [a]	Memorandum			
Department of State				
(Bureau of Oceans and International Environmental and Scientific Affairs)				
Department of Transportation [a]	×	×		
U.S. Coast Guard [a, b]				
Federal Aviation Administration [a, b]				
Federal Highway Administration [a, b]	×			
Federal Railroad Administration [a, b]				

Table 6–2 (continued)

Federal Agency	Floodplain Regulations		Wetlands Regulations	
	Draft	Final	Draft	Final
Urban Mass Transit Administration [a, b]				
Saint Lawrence Seaway Development Corporation [a, b]				
Department of the Treasury	×	×		
Environmental Protection Agency	×	×		
Office of Solid Waste Management				
Office of Water Planning				
Office of Water Supply				
Independent Agencies				
Advisory Council on Historic Preservation				
Action				
Community Services Administration [a]				
Federal Communications Commission [a]	×			
Federal Home Loan Bank Board				
Federal Reserve System				
Federal Preparedness Agency	×			
General Services Administration [a]	×			
International Boundary Water Commission	×	×		
National Aeronautics and Space Administration	×	×	×	×
Nuclear Regulatory Commission	×			
Small Business Administration	×			
Tennessee Valley Authority [a]	×			
U.S. Postal Service	PS Bulletin		×	
Veterans Administration	×	×		
Water Resources Council [a]				

Notes: Executive Order 11988 applies to all proposed actions and Section 2(d) of the order requires that each agency shall comply with the order by issuance of regulations or procedures. The agencies listed above appear to conduct activities affecting floodplains based on program descriptions in the Federal Government Organization Manual. Agencies dealing with services unlikely to affect floodplains (such as personnel management or mediation) have not been included. Procedures for the 13 cabinet-level agencies may cover all of their subunits and obviate the need for separate subunit procedures.

[a] Status report for May 30, 1979 has been received.

[b] Will operate under U.S. Department of Transportation regulations.

Source: Unpublished materal provided by the U.S. Water Resources Council, July 1979.

INTEGRATED WATER MANAGEMENT

As the foregoing discussion of water resource problems suggests, a more comprehensive approach to the management of both surface and ground water and related land resources is needed at all levels of government. This need was stressed in President Carter's June 1978 Water Policy Message [21] and was re-emphasized in a study by the U.S. General Accounting Office (GAO), released in April 1979, on the relationship between water resources and future water supply needs in the United States.[22]

The GAO study pointed out that the increases in consumptive use by the year 2000 projected by the WRC *National Water Assessment* will compound existing water supply problems. Both the Presi-

dent's message and the GAO report state that although the federal government has an important role in planning, developing, and managing water resources, the primary responsibility for ground and surface water management remains with the states. The GAO report noted, "the greatest potential, as well as the greatest need, for better water management and conservation is in the irrigated areas of the West." [23] The report suggests that greater attention be given to ground water depletion and pollution problems, and that more information be obtained on surface and ground water interrelationships so that conjunctive use of surface and ground waters can be planned effectively. Additional GAO reports on the potential for integrated water management are planned for release later this year.

IMPLEMENTATION OF WATER POLICY INITIATIVES

Throughout 1979 progress was made on implementing the series of water policy reform initiatives announced by President Carter in his June 6, 1978, Water Policy Message. These initiatives, discussed in last year's Annual Report,[24] may be grouped under four basic goals:

- To improve the planning and evaluation of federal water resources programs to promote projects that are cost effective, safe, and environmentally sound;
- To place a new national emphasis on water conservation, including demand-reduction measures and greater efficiencies in water use;
- To give increased attention to environmental requirements and values in planning and management of water programs and projects; and
- To enhance federal/state cooperation in water planning and resource management.

To implement the numerous initiatives in his Water Policy Message, the President issued on July 12, 1978, a set of 13 directives to federal agency heads. These directives assigned responsibility for the various initiatives to specific agencies, established deadlines for action to be taken, and provided for overall coordination by the Secretary of the Interior in consultation with CEQ and the Office of Management and Budget (OMB).

Nineteen task forces were formed to carry out the implementation process. Public workshops and information meetings were held across the country, and draft task force reports were made available for public comment. By the end of June 1979, approximately half of the task forces had completed preliminary reports.

Significant implementation actions taken during 1979 include the following:

- The President issued an Executive order establishing an independent water project review function within the WRC; [25]
- The Administration transmitted to Congress proposed legislation that would (1) increase the authorization for grants from WRC to the states to help finance comprehensive water planning and man-

agement and provide technical assistance for water conservation,[26] and (2) expand the role of the states in water project decision-making and financing, including a provision to standardize local cost sharing for both structural and nonstructural measures at 20 percent;[27]

- The WRC proposed rules for evaluating economic benefits and costs in federal water resources project planning, and proposed revisions to its Principles and Standards;[28]
- The Advisory Council on Historic Preservation published final amendments to regulations under the National Historic Preservation Act that improve protection of historic and cultural resources in water project planning;[29] and
- The U.S. Interior and Commerce Departments proposed regulations to implement the Fish and Wildlife Coordination Act, to improve protection of fish and wildlife habitat in water project planning and construction.[30]

Additional legislative and administrative proposals were being developed by the task forces as of early July 1979.

CONGRESSIONAL ACTIONS

The 95th Congress took two significant water policy-related actions in late 1978.

After a hard-fought struggle, on October 5, 1978, the House of Representatives sustained the President's veto of the fiscal year 1979 public works appropriations bill (H.R. 12928), by a margin of 53 votes. President Carter vetoed the bill because it included funding for more than two dozen water projects that did not meet minimum Administration economic or environmental standards and would ultimately have cost $1.8 billion dollars to construct. The vote was viewed on both sides as a major test of the President's water policy reforms. After the veto was sustained, the House and Senate quickly passed and the President signed a substitute bill that deleted funds for most of the projects opposed by the Administration.

The same month, after another protracted debate, the Congress passed and the President signed a bill that established a tax on fuel used for commercial navigation purposes on the nation's inland waterways.[31] The bill was viewed by the Administration as a first step forward in recovering some of the federal cost of constructing and operating the inland waterway system, which previously had been operated without cost to commercial users. Similar legislation had been sought without success by every President since Franklin Roosevelt. The fuel tax established by this law will rise in steps to a maximum of 10 cents per gallon after September 30, 1985, and will be placed in a trust fund that can be used to help finance new waterways construction projects.

This legislation was a stated Administration condition for acceptance of another controversial bill—the authorization for a replacement of Locks and Dam #26 on the Mississippi River above St.

Louis, Mo.[32] Environmental and railroad interest groups had opposed the replacement and expansion of this structure, arguing instead for rehabilitation of the existing facility. They maintained that additional traffic accommodated by the new lock and dam would damage the natural environment of the upper Mississippi and would be an unjustified additional federal subsidy of one form of surface transportation to the detriment of another.

Controversy over key elements in the Administration's water policy continued in the 96th Congress. The House passed an energy and water development appropriations bill [33] that generally avoided funding projects opposed by the Administration and included substantial funding for the WRC, including the independent review board and the grant programs. However, the Senate passed a bill extending WRC's life for 1 year, but prohibiting the expenditure of any funds or staff time on any independent review activities. The Administration countered by indicating that no new projects would be likely to receive budget support until the WRC review process was completed. As of early July 1979 these issues were still unresolved.

AGRICULTURAL LANDS

SOIL EROSION: EXTENT OF LOSSES

Despite an investment by the federal government of more than $20 billion in support of soil conservation practices since 1935, erosion of agricultural lands remains one of the nation's most serious problems.[34] Erosion both pollutes the water and reduces the productivity of the land. The 1977 National Resource Inventory Estimates [35] (NRI) show a national average annual loss from water-induced surface sheet and rill erosion in excess of 4 billion tons. Additionally, agricultural runoff adversely affects the water quality of two-thirds of the nation's river basins. The principal pollutants are sediment, dissolved solids, nutrients, pesticides, other organic materials, and pathogens.

As noted in Tables 6–3 and 6–4, cropland is the source of almost half of the quantity and often the most severe forms of erosion.

NRI data show that the average annual erosion rate from cropland is four times that of forestland (see Table 6–3). Well-managed forests represent a minimal risk of soil losses from sheet and rill erosion,[36] and pastures when not severely overgrazed are also normally well protected from erosion.[37] However, rangeland still contributes significantly to national soil losses from sheet and rill erosion, though less than cropland.

Nearly half of the cropland currently cultivated consists of soils classified as having a high potential for erosion. More than 70 percent of the erosion from these cropland soils is occurring on the "better" classes of soil. However, the per-acre rate is relatively low, which

Table 6–3

Annual Sheet and Rill Erosion for All Land Capability Classes in the United States

Land Use	Average Annual Erosion Rate (tons/acre)	Acres (millions)	Total Erosion (millions of tons)
Cropland	4.8	412	1978
Rangeland	3.4	408	1387
Forestland	1.2	367	440
Pastureland [a]	2.6	133	346
Total			4151

[a] Includes native pasture.

Source: U.S. Department of Agriculture, Soil Conservation Service, *1977 National Resource Inventory.*

Table 6–4

Ranges of National Average Erosion Rates by Land Use

Land Use	Erosion Rates (tons/acre)	
	Low	High
Cropland	0.83	15
Rangeland	0.22	6.4
Forestland [a]	0.02	2.5
Pastureland [b]	0.13	12.6

[a] Ranges are derived from an average of the land capability class soils used for the purpose noted.
[b] Includes native pasture.

Source: U.S. Department of Agriculture, Soil Conservation Service, *1977 National Resource Inventory.*

suggests that the adoption of appropriate soil management practices could reduce these erosion rates to levels consistent with sustained production. The per-acre rates of erosion from the poorer soil classes, which comprise less than 3 percent of the nation's cropland, are so high that proper erosion controls, if adopted, would often preclude the use of such soil as cropland. For example, the cultivation of highly erodible soils, which were previously used less intensively, may be part of the reason that rates of soil erosion in Iowa in 1974 were the highest in 25 years. Four and one-half million acres eroded at rates exceeding 10 tons per acre per year. Erosion rates as high as 200 tons per acre per year occurred in some areas.[38]

Steep slopes, easily eroded soils, intense rainfall, and other natural or manmade conditions have combined to cause critical soil erosion problems in every state. The erosion hazard is greater in some states than in others. The hilly loess soils along the Missouri and Missis-

sippi Rivers are among the more erodible in America. Other regions highly susceptible to erosion include the Piedmont along the Eastern Seaboard and the intensively grazed or cultivated soils of the arid Southwest.

Areas where the WRC found erosion or sedimentation to be a significant problem are indicated in the accompanying map (see Figure 6–3). The nation's most serious soil erosion problems are currently in parts of Arizona, New Mexico, and Nevada, and in the Mississippi and Ohio valleys (including most of Illinois, Ohio, Kentucky, Pennsylvania, and Indiana). However, local problems elsewhere may also be quite significant. Texas and Illinois are experiencing average annual erosion losses from cropland of 7 to 10 tons per acre; Virginia and Tennessee, with rolling topography, are losing from 20 to 30 tons per acre. In western Tennessee intensive production of soybeans and cotton on steep loess soils greatly aggravates erosion, particularly because the two crops leave little plant residue to protect the soil after harvest. Some soils in western Tennessee that have no conservation treatment average more than 90 tons of soil loss per acre per year.

Erosion on clay and shale soils in Arkansas. An attempt to seed and reclaim this area failed. Photographer: Joe L. Gaston.

Figure 6–3

Areas of Erosion and Sedimentation Problems

Explanation

- Area in which erosion or sedimentation is a significant problem
- Unshaded area may not be problem-free, but the problem was not considered major

Nature of erosion or sedimentation problems

- Cropland or rangeland erosion or sedimentation
- Urbanization, mining, or industrial and highway construction
- Natural erosion of stream channels
- Shoreline, streambank, or gully erosion
- Sedimentation of farm ponds, lakes, water supply, and flood-control channels

Boundaries

- Water resources region
- Subregion

Source: U.S. Water Resources Council, *Second National Water Assessment*, 1978, Vol. 1, p. 71.

IMPACT OF EROSION ON PRODUCTIVITY

The nationwide loss of plant nutrients due to erosion is significant. A study published by the U.S. Department of Agriculture (USDA) indicates that more than 50 million tons of plant nutrients (nitrogen, phosphorus, and potassium) are lost annually from U.S. cropland.[39] USDA estimates the annual cost of replacing all of the nitrogen and phosphorus and one-fourth of the potassium lost by soil erosion at $7.75 billion in 1965 dollars.[40] This converts roughly to $18 billion in 1979 dollars. The following figures may provide a better perspective of how soil erosion and accompanying nutrient losses can affect productivity. In the Southern Piedmont, a 6-inch reduction in topsoil has been found to reduce average corn yields by 41 percent.[41] In western Tennessee, similar soil erosion reduced corn yields 42 percent.[42] Adams [43] and Buntley and Bell [44] found this degree of erosion reduced the yields of vetch and fescue forage 25 percent and of wheat-oat grains nearly 30 percent.

A recent report of the U.S. Soil Conservation Service in Missouri contained similar findings on the effects of erosion on crop yields: "Yields of 120 bushels of corn are reduced to 96 bushels by moderate erosion and to 75 bushels by severe erosion. The severity of the problem is greater in areas of the state where there are limited amounts of high-producing soils." [45] The report points out another damaging effect of erosion as well: reduced breakdown of toxic substances.

> . . . the fertility of the soil allows microscopic inhabitants to degrade the applied herbicide or insecticide. The major factors governing the destruction appear to be soil moisture, pH, depth and organic matter level. An ample supply of organic matter or the presence of a thick, dark, surface soil will shorten the period of persistence of toxic residue. Therefore, soils of high fertility contain favorable conditions for degrading or breaking down chemical residues, whereas eroded soils lack the necessary properties. This allows toxic residues to remain for long periods of time or to be carried away by runoff.[46]

In the past, the adverse effects of soil erosion on the productivity of the land have been somewhat obscured by other conditions, including climate. Recent evidence suggests that weather patterns from 1900 to 1970 were unusually favorable for agriculture.[47] The period between 1930 and 1960, defined as the climatological norm, now appears to have been the most abnormally mild period in the past 11,000 years.[48] The development of new and more productive crop varieties (often bred to maximize yield in conjunction with the heavy use of fertilizers and pesticides) has also partly compensated for the effects of erosion, as has better control of pest and crop diseases, together with improved tillage and planting methods. In recent years, yields of major crops have not risen as fast as they did in the fifties and sixties.[49] In some cases the yields have leveled off; in others they have decreased.[50] Some analysts have suggested that traditional yield-improving technologies have been exploited to the point of diminishing returns.[51]

EROSION CONTROL

New agricultural technologies therefore must seek to decrease soil erosion while maintaining or increasing crop production. Some soil conservation practices do increase production by making better use of soil moisture, improving the crop climate conditions, and increasing the nutrients available to plants.

Various studies have shown that conservation measures on sloping land increase crop yields. Contour planting increased cotton yields in Texas 25 percent by conserving soil, moisture, and nutrients.[52] Studies in Illinois found that contouring increased yield of corn 12 percent, soybeans 13 percent, and wheat 17 percent.[53]

A newer approach is minimum-tillage farming. Using these techniques, a farmer does not usually plow a field prior to planting, but rather plants seeds and applies fertilizer and pesticide simultaneously.

Erosion from Georgia cotton field. Contour planting was not employed. Photographer: R. W. Oertel.

Minimum-tillage techniques involve a series of trade-offs.[54] They have certain important advantages:

- Erosion by both wind and water is more effectively controlled;
- More water is available for plant growth because surface plant residues increase infiltration, reduce evaporation, and lower soil temperature;
- Less energy and labor are required for fertilization, plowing, and cultivation; and
- Harvesting is easier in wet weather because the soil is firmer.

Minimum-tillage farming also has significant disadvantages:

- Chemical costs for herbicides are high; herbicide use is often more than twice as high as under conventional cultivation;
- Herbicide use may degrade water quality, and its use increases the opportunity for resistant varieties of weeds to develop;
- Herbicide buildup may damage subsequent crops;
- Chemical costs for insecticides may be higher because pest insect populations may be encouraged by the more stable habitat provided by minimum-tillage techniques;
- Minimum-tillage production, in general, requires more intensive farm management than conventional tillage;

- The presence of plant residues may delay spring planting because soil temperatures do not increase nor does excess moisture evaporate as rapidly as in plowed fields; and
- Certain soils—the flat, dark colored, poorly drained soils of Indiana, Ohio, and Illinois for example—produce lower crop yields under surface residue systems than under conventional tillage.[55]

SUSTAINED YIELD AGRO-ECOSYSTEMS

Clearly, there are circumstances where it may be advantageous to employ minimum-tillage agriculture, and other circumstances where it may not. Agricultural specialists such as R. M. Davis, Administrator of the USDA Soil Conservation Service, now believe that no single approach can be a panacea for agriculture. Rather, what is needed is the development of integrated farming systems, which include comprehensive planning for: capital requirements; machinery; fertilizer needs; weed, insect, and disease control; suitable plant varieties; soil and water management; fuel needs; and tillage systems.[56]

One such integrated approach to agriculture has been called the Sustained (or Sustainable) Yield Agro-Ecosystem or SYAE. This approach seeks to maintain productivity on a long-term sustainable basis. It uses the ecosystem as its planning unit. In Iowa and northern Illinois, for example, corn and soybeans constitute the minimum ecosystem unit. Rotating them is an elementary means of weed, insect, and disease control. Rotation management reduces brown stem rot of soybeans, the soybean cyst nematode, and corn root worms, to mention a few pests affected; continuous cropping with herbicide control of annual weeds worsens the problem of perennial weeds.

To establish a SYAE, it is necessary to determine and work within the long-term carrying capacity of the land. The criteria for an SYAE are that: (1) the chemical nutrients removed by crops are replenished in the soil; (2) the physical condition of the soil by land utilization type is maintained, which means that the humus level in the soil is constant or increasing; (3) there is no buildup of weeds, insects, and pathogens; (4) there is no increase in soil acidity, or of toxic elements; and (5) soil erosion is effectively controlled.

One tool for working toward these goals is Integrated Pest Management (IPM), discussed in last year's Annual Report.[57] IPM is a system of controlling pests through a combination of techniques, including natural predators and biological controls, use of pest-resistant varieties, modifying environmental conditions, close monitoring of pest levels, and use of chemical pesticides only when needed as part of an overall control strategy. CEQ was scheduled to publish in late 1979 a comprehensive examination of IPM practices in the United States, with particular emphasis on the current and potential role of the federal government in IPM research, education, and implementation.[58]

THE RESOURCES CONSERVATION ACT

The 1977 Soil and Water Resources Conservation Act (RCA)[59] directed the Department of Agriculture, through the Soil Conservation Service, to undertake a major national appraisal of the quantity and quality of the nation's agricultural land and water resources as well as an evaluation of USDA conservation, research, and assistance programs. The RCA also requires USDA to develop and recommend plans to attain projected food and fiber needs while meeting soil maintenance and water quality goals.

Secretary of Agriculture Bob Bergland directed that RCA be implemented through a Coordinating Committee comprised of all relevant USDA agencies, including the Soil Conservation Service, Forest Service, Agricultural Stabilization and Conservation Service, Economics Statistics and Cooperative Service, Farmers Home Administration, and the Rural Electrification Administration.

The Coordinating Committee has directed the RCA staff team to: (1) appraise the status of soil and water resources; (2) project domestic and export food and fiber demands and resource requirements; (3) examine potential environmental and resource problems that may arise in meeting projected demands; (4) establish feasible soil and water conservation objectives; (5) develop and compare alternative strategies to meet projected demand and environmental goals; and (6) select a set of USDA soil and water conservation program alternatives.[60]

After considering public comment, USDA will recommend to the President and the Congress a specific program strategy. This analysis and recommended strategy will guide USDA's programs for the next decade; it will be followed by a series of annual updates and additional specific studies. A second comprehensive report is due in 1985.

The resource appraisal efforts under RCA will be coordinated with the resource assessment effort required by the Forest and Rangeland Renewable Resources Planning Act (RPA) described in last year's Annual Report, and used in preparing the Forest Service's 1980 Renewable Resources Assessment and Program.

RETENTION OF AGRICULTURAL LANDS

As noted in last year's Annual Report,[61] prime farmlands are the most efficient, energy-conserving, environmentally stable lands available for meeting food and fiber production needs. Nevertheless, development pressures are converting prime lands to nonagricultural uses nationally at a rate of about 1 million acres per year. Agricultural lands of all types are collectively being converted at a rate of about 3 million acres per year.

The chief consumer of farmland is urban sprawl. A particularly deleterious form of urbanization—leapfrog, scatter, or "buckshot" development—results in developments that surround and isolate individual farmers or farming areas.

These farmers may develop what some term the "impermanence syndrome," lessening concern for use of the best production and conservation methods while contemplating selling their land to residential or commercial developers for a substantial price.[62] Such a process has contributed to the virtual elimination of truck-farming and other food-producing areas near major cities, especially in New England, which is increasingly dependent on food supplies shipped from great distances. The weather conditions during recent winters, combined with growing concern over the availability of gasoline and diesel fuel needed for long-distance transportation of food supplies, have prompted new worry over diminishing farmlands.

As an initial step in the investigation of this problem, the National Conference of State Legislatures (NCSL) prepared for CEQ a survey of state laws and regulations that are intended to help preserve agricultural lands.[63]

The NCSL inventory found that although 48 of the 50 states had adopted farmland preservation measures (see Table 6–5), most states had dealt with the issue primarily through provisions allowing preferential property tax assessment, that is, taxation of farmlands at a lower rate than land used for residence or other purposes. All states but Georgia and Mississippi, and technically Arkansas,[64] have such provisions on their books. However, officials contacted in connection with the current survey confirmed the conclusions in CEQ's earlier report, *Untaxing Open Space* (1976), that preferential assessment by itself has had a minimal effect in preventing conversion of farmland to other uses. "Rollback provisions," which require repayment of past tax benefits as a penalty for conversion, were generally considered too limited; some states advocated at least doubling the present 3- to 4-year period for applying this recapture measure.

Among the other types of preservation programs highlighted in this survey, three continue to attract the most attention in the states: purchase of development rights, agricultural districting, and transfer of development rights.

Purchase of Development Rights (PDR) Of all preservation programs, this one is presently generating the most interest. The general practice is for the local government to create easements under which a certain amount or intensity of development may occur. These "development rights" are then purchased by the local government for an amount equivalent to the difference between the value of the land as farmland and its value if it were developed. As an approach to preservation, however, the costs appear to be prohibitive. A PDR pilot program in New Jersey was recently abandoned when it was determined that the total amount appropriated for this purpose—$45 million—would purchase the rights to only a relatively few acres. Some Maryland counties are trying a more cautious program in which farmers seek to have the development rights to their land purchased by the county government, rather than have the program automatically pay the difference between the farm value and development value of the land.

Table 6–5

State Programs for Preservation of Farmland, by Type of Program

State	Preferential property tax assessment	Preferential property tax assessment with deferred taxation	Preferential taxation with restrictive agreement	Circuit breaker state income tax credits	Inheritance and estate taxation	Land gains taxation	Agricultural districts	Agricultural zoning	Purchase of development rights	Transfer of development rights	Land use commissions	Land banking
Alabama		s										
Alaska		s							b	s		
Arizona	s											
Arkansas	s											
California			s			b		b				
Colorado	s											
Connecticut	s				s				s			
Delaware	s											
Florida	s											
Georgia												
Hawaii			s					s	b		s	s
Idaho	s											
Illinois		s				b						
Indiana	s											
Iowa	s										s	
Kansas		s			s							
Kentucky		s			s							
Louisiana	s											
Maine		s							s			
Maryland		s, b							s	b		

Massachusetts		s							s			s
Michigan			s	s	s							
Minnesota		s	b	b								
Mississippi												
Missouri	s											
Montana		s				b						
Nebraska		s										
Nevada		s										
New Hampshire			s						b			
New Jersey		s							s, b	b		
New Mexico	s											
New York		s			s		s			b		
North Carolina		s										
North Dakota	s			b								
Ohio		s					b					
Oklahoma	s											
Oregon		s				b		s			s	
Pennsylvania		s	s				b					s
Rhode Island		s										
South Carolina		s										
South Dakota	s											
Tennessee		s			s							s
Texas		s										
Utah		s										
Vermont		s				s						
Virginia		s				b	s		b			
Washington		s, b				b						s
West Virginia	s											
Wisconsin			s	s				s				
Wyoming	s											

s=statute or program
b=bill

Source: Bob Davies and Joe Belden, *A Survey of State Programs to Preserve Farmland,* (Washington, D.C.: Council on Environmental Quality, 1979).

Agricultural Districting This program was instituted as a farmland preservation method in New York in 1971. Such districts represent a compromise between rigid zoning and preferential assessment. Agricultural districting consists of designating geographic areas for long-term farming, along with a combination of measures designed to offset the spillover effects of urbanization that make continued farming difficult.

Such districts usually include limitations by the state on the powers of local government to regulate farming practices that may be offensive to suburbanites because of smells, dust, noise, etc.; limitations on the powers of state and county governments to locate roads, sewers, water mains, public institutions, and other urban infrastructure in or near an agricultural district; and limitations on the power of utilities

Many states are experimenting with programs for preservation of agricultural lands from development such as the mobile home park pictured above.

to assess farmers in a district on a front-foot basis for utility lines that run through or along their property. The designation of the boundaries of an agricultural district may be based on soil quality and current use for agriculture.

A minimum allowable size for a district may also be stipulated. Virginia has passed a program modeled after the New York law, and Illinois, Ohio, and Pennsylvania are considering similar bills.

Transfer of Development Rights (TDR) Such programs are being considered by Maryland, New Jersey, and New York. These programs would empower local governments to delineate preservation and transfer zones (or sending and receiving districts) and create machinery for transmittal and use of development rights from the preservation zones to the receiving districts. This approach combines the concept of zoning with compensation, which in this case comes from developers who wish to build on less restricted land. TDR was first developed to protect urban landmarks, but its application to the preservation of farmland, habitats of ecological value, landscapes of aesthetic value, and other purposes has been widely discussed. State-coordinated programs are being considered, because in those jurisdictions where local governments are presently allowed to undertake a modified form of TDR program (usually under an "open space act"), only a few have participated. These are scattered throughout the state, with developers simply crossing into adjoining jurisdictions where few or no limitations on development exist.

During the NCSL survey, a number of state officials expressed the opinion that loss of farmland is sometimes caused by federal programs that encourage urban sprawl, directly or indirectly. They acknowledge that recent policy statements and executive memoranda from the CEQ, USDA, EPA, and Economic Development Administration have encouraged federal agencies to look more carefully during project planning at such potential impacts. But many persons concerned about farmland conversion believe a more thorough, government-wide effort to coordinate federal programs and policies is needed, particularly including programs providing assistance for sewer and water systems, highways, housing, public buildings, and shopping centers. Officials cited federal legislation sponsored by Congressman James Jeffords (R–Vt.) and Senator Warren Magnuson (D–Wash.) numerous times in this regard. Both bills [65] call for coordinating federal policies with state and local farmland preservation programs and financing demonstration programs to test and refine preservation methods. As of July 1, 1979, neither bill had been passed by the Congress.

Another type of program, exclusive agricultural zoning, has appeared to many to be a straightforward method of restricting certain lands to farming. Zoning can forbid any development incompatible with farming and rural uses. Although state and local governments may have the authority to apply such zoning structures, politically these steps have proven difficult. A strong zoning bill has been con-

sidered several times in California but has not passed. A few states, Oregon among them, have adopted some form of agricultural zoning.

One alternative for state governments may be to combine the key elements from a number of methods into more comprehensive systems of farmland preservation. Legislators and other state government officials in Pennsylvania and Maryland, for instance, evinced interest in combining the basic elements of agricultural districting legislation with tax credits or purchase of development rights. However, the results of such combinations may be to produce very complex programs.

NATIONAL AGRICULTURAL LANDS STUDY

In response to growing expressions of concern about the availability of agricultural lands, Agriculture Secretary Bergland and CEQ Chairman Warren initiated an 18-month federal study of the availability of agricultural lands—particularly prime farmlands—and their conversion to other uses. The study will evaluate the economic, environmental, and social effects of the conversion or retention of agricultural lands and will make recommendations for consideration by federal, state, and local governments.

The interagency study will focus on the availability of agricultural land and determine its adequacy to meet America's future domestic food needs and international trade and overseas food aid. The study will determine and evaluate:

- The agricultural land resource base including quantity, quality, and ownership patterns;
- Current pressures on agricultural land such as urban and industrial development, transportation, and energy requirements;
- The economic, environmental, and social effects of agricultural land conversion and retention;
- The impacts of federal programs and policies on agricultural land; and
- The actions that state and local governments have taken to insure agricultural land availability.

The study is to be completed by January 1, 1981.

PARKS, WILDERNESS AREAS, AND REFUGES

In response to public sentiment that more of the nation's especially scenic and wild undeveloped lands be given permanent federal protection, a number of legislative proposals were put before Congress in 1978 and 1979. On November 10, 1978, Congress passed the National Parks and Recreation Act of 1978,[66] which made major additions to the nation's Wild and Scenic Rivers System and the first additions to the National Scenic Trails System since the system was created a decade ago. The Act also created eight new wilder-

ness areas covering almost 2 million acres, and added to the National Park System. Other proposals are still pending, including an Administration proposal to designate 15 million acres of roadless National Forest land as wilderness, and a bill to reserve more than 100 million acres of wild lands in Alaska for permanent federal protection and management.

ALASKA

Debate continued through 1979 over the disposition of Alaska's vast wilderness. The Alaska Statehood Act of 1959 authorized Alaska to select 103 million of the 375 million acres that comprise Alaska to use as the state sees fit. In addition, the Alaska Native Claims Settlement Act of 1971 [67] authorized giving 44 million more acres to Alaska's indigenous peoples. These selections have been delayed while Congress decides which lands currently in federal ownership to protect permanently through inclusion in the National Forest, Park, Wildlife Refuge, and Wild and Scenic Rivers systems. Last year the Administration-supported Alaska National Interest Lands Conservation Act, which would have designated 102 million acres of Alaskan lands for such protection, passed the House by a 277–31 margin. However, the Senate Energy and Natural Resources Committee did not report out its version of the bill until 5 days before the close of the 95th Congress; this delay, plus a threatened filibuster, prevented final Senate action on the bill.

The Administration and major organizations supporting federal protection of Alaska's wild lands were concerned about this lack of action, because interim protection granted to 80 million acres of this land by Section 17(d)(2) of the Alaska Native Claims Settlement Act of 1971 was due to expire December 17, 1978. The Secretary of the Interior had withdrawn these "d–2" lands from state selection on December 17, 1973, for a period of 5 years while they were studied for possible designation as National Forests, Parks, Wildlife Refuges, or Wild and Scenic Rivers.[68]

Faced with Congressional inaction, President Carter and Interior Secretary Andrus moved to protect Alaskan lands. Invoking the authority granted him under Section 204(e) of the Federal Land Policy and Management Act (FLPMA) also known as the BLM Organic Act, Interior Secretary Andrus on November 16, 1978, withdrew from state selection 110 million acres of Alaskan land. This had the effect of renewing protection for the 80 million acres previously withdrawn and preserving them from development, along with an additional 30 million acres, until such time as Congress could provide appropriate legislative protection.[69] The 204(e) withdrawal also precludes new entry under the mining and mineral leasing laws for a period of 3 years.

Then, on December 1, 1978, President Carter issued an historic series of proclamations [70] invoking the Antiquities Act of 1906, which set aside 56 million acres as 17 national monuments, thus protecting

Inside the crater of Aniakchak Caldera National Monument, one of 17 new national monuments designated by President Carter in 1978.

a total of 113.5 million acres. This Act, never before used by a Chief Executive for such extensive land withdrawals, allows a President to preserve areas noted for their extraordinary scientific, historic, and cultural values. This Executive action permanently protects these lands from any adverse development or mineral entry unless the order is superseded by an act of Congress.

The State of Alaska promptly filed suit (*State of Alaska* v. *Carter*) calling this action unconstitutional. As of July the Court had not decided the case.[71]

The President urged the 96th Congress to act promptly on the federally held Alaskan lands in 1979 because "[t]his Carter Administration believes that ultimately Congress should make the final decision and the Alaskan land issue should be resolved by legislation." [72]

On May 16 the House of Representatives passed by a margin of 360 to 65 a new Alaskan lands bill, sponsored by Representatives Morris Udall and John Anderson, which would place 126.2 million acres under one or another of the four federal land protection systems. This bill had the strong support of the Administration, most local and national conservation groups, some labor unions, and outdoor and civic organizations. Some 50 of these interest groups joined together to

form the Alaska Coalition, which became the dominant public interest group supporting the passage of the Udall-Anderson bill. The key House vote was between the Udall-Anderson bill or the industry-backed Breaux-Dingell-Huckaby bill. The Administration-backed bill was adopted by a vote of 268 to 157. As of July, the Senate had not yet taken up the legislation.

WILDERNESS AREAS

During fiscal year 1979, Congress passed and the President signed the National Parks and Recreation Act of 1978, also known as the "Omnibus Parks" Act.[73] The Act made significant additions to the Wilderness System, giving wilderness status to 1.85 million acres of National Park Service lands in eight locations.

Congress also acted during the past year to enlarge the existing Boundary Waters Canoe Area in Minnesota.[74] The area now encompasses 736,853 acres along the United States-Canada border. Also designated as wilderness were Blackjack Springs (5,886 acres) and Whisker Lakes (7,315 acres) in Wisconsin;[75] Indian Peaks (70,000 acres) in Colorado;[76] Great Bear (285,771 acres) in Montana;[77] and a 60,000 acre addition in Montana to the existing Bob Marshall Wilderness (1,900,356 acres).[78] These areas are all administered by the Forest Service.

The largest and most controversial wilderness issue of 1978 and 1979 was the Forest Service's Roadless Area Review and Evaluation Process (RARE II). In June 1977, the Forest Service initiated a special review of all remaining roadless areas in the National Forest System in order to determine whether some of these lands should become part of the Wilderness System rather than be retained for multiple use. RARE II surveyed 2,919 wild and untouched tracts of National Forests and National Grasslands, totalling 62 million acres in 38 states.[79]

Logging companies, backpackers, fishermen, and local businesses all had interests at stake in this process. The draft Environmental Impact Statement (EIS), which contained the Forest Service's initial evaluation of which areas should be retained as wilderness, drew more than 264,000 letters from nearly 360,000 people—the largest response ever received by a federal agency on an EIS.[80]

In the RARE II Final Environmental Impact Statement released January 4, 1979, the Department of Agriculture recommended that 15 million acres of National Forest land be designated as wilderness. Of this, 9.5 million acres are in the lower 48 states and Puerto Rico. Additionally, 10.8 million acres were designated to receive further study, and 36.2 million acres were allocated to nonwilderness (28.6 million acres excluding Alaska).[81]

The Secretary of Agriculture solicited comments on the Final EIS from interested governors and members of Congress.

After considering these comments and the results of the interagency review process, the President concurred, with only a few

exceptions, with the recommendations in the Final EIS and announced his wilderness recommendations on April 16, 1979. The President recommended an additional 400,000 acres of wilderness.[82]

Congress has retained the final authority to designate federal land as wilderness. If Congress acts favorably on the Administration's recommendations, it will more than double the wilderness acreage administered by the Forest Service and quadruple the number of wilderness acres in the heavily populated states east of the Mississippi (see Table 6–6).

The Bureau of Land Management, as required by the Federal Land Policy and Management Act,[83] has begun a separate wilderness inventory and evaluation process on 174 million acres of its lands. The review will be completed by 1991.

In January 1979,[84] the BLM released draft guidelines for management of areas under study during the evaluation period. Wilderness supporters expressed concern that the guidelines covering oil and gas exploration on these lands might allow actions that would impair an area's wilderness characteristics while the lands were still being studied. BLM acknowledged these concerns by recognizing that "(c)ontrols on exploration and development will have to be so stringent that it will be relatively special oil and gas activities that can actually take place in a wilderness proposal."[85]

The first step of the BLM review was completed when all western offices published their proposed initial inventory of areas clearly and obviously lacking wilderness characteristics (a total of 113 million

Table 6–6

Designated and Proposed Wilderness, 1964–76

(in millions of acres)

Year	Designated		Proposed/Under Study		Grand Total
	Annual Addition	System Total	Annual Addition	System Total	
1964	9.244	9.244	37	37	46.24
1965	0	9.244	0	37	46.24
1966	0	9.244	0	37	46.24
1967	0	9.244	0	37	46.24
1968	.788	10.032	0	37	47.03
1969	.159	10.191	0	37	47.19
1970	.204	10.395	.21	37.21	47.60
1971	0	10.395	.55	37.76	48.15
1972	.631	11.026	.20	37.96	48.99
1973	0	11.026	0	37.96	48.99
1974	.354	11.380	.62	38.58	49.96
1975	1.336	12.716	.27	38.85	51.57
1976	1.738	14.454	.65	*39.50	53.95

*In addition, the 1976 BLM Organic Act includes approximately 174 million acres of BLM lands which are under consideration for Wilderness designation.

Source: U.S. Department of Agriculture, Forest Service, August 1, 1977.

acres). The remaining 61 million acres were defined as needing intensive inventory in order to establish whether or not the areas have significant wilderness characteristics. This intensive inventory has been carried out on the California Desert Conservation Area, where BLM determined that 5.5 million acres of BLM-administered land there have wilderness characteristics. The areas within this 5.5 million acres have become wilderness study areas and are now being examined under the California Desert Conservation Area Planning Process. The intensive inventory phase will be carried out on the other 56 million acres by 1980. The areas selected by intensive inventory will become "wilderness study" areas to be carefully considered during BLM resource management planning (land use planning) to determine whether the Secretary of the Interior should recommend to Congress their inclusion in the wilderness preservation system.

WILD AND SCENIC RIVERS

The "Omnibus Parks" Act of 1978 [86] also added eight new river segments (a total of approximately 696 miles) to the National Wild and Scenic Rivers System (see Figure 6–4). This was the largest single addition since the passage in 1968 of the Wild and Scenic Rivers Act,[87] which created the system. The Wild and Scenic Rivers System now protects a total of more than 2,317 miles of 27 rivers (see Table 6–7). The "Omnibus Parks" Act authorized $54 million for land acquisition along five previously designated rivers—Eleven Point, Rogue, St. Croix, Salmon, and Chattooga. An additional $44 million was authorized for land acquisition for the eight newly designated rivers, and for some development activities along the Missouri River. The Act also designated 17 additional rivers for study, bringing the total in this category to 75. A limit of 5 years for the study process was also established by the Act.

This last provision was in part a response to criticism that the Wild and Scenic Rivers program was taking too long to complete river studies. In a report released in May 1978, the General Accounting Office found that the addition of rivers to the system had been a slow and costly process.[88] River studies, hampered by a shortage of experienced personnel on the study teams, suffered from duplication of information, and lack of coordination among federal, state, and local agencies. As a result, the studies have been taking, on the average, 6.5 years to complete. The study of Idaho's Bruneau River, for example, was authorized in 1968 but not completed until 1976.

According to the report, the long study delays have encouraged land speculation, which has increased land prices along potential Wild and Scenic Rivers. Inappropriate development has adversely affected the primitive or aesthetic value of some rivers. The GAO report also contended that the Departments of Agriculture and Interior have spent more money than necessary creating the system because they have relied too much on outright purchase of lands surrounding the

Table 6–7

River Segments Included in the National Wild and Scenic Rivers System

River	Administering Agency	Wild	Miles by Classification		Total Miles	Total Acres [a]
			Scenic	Recreational		
Middle Fork Clearwater, Idaho (P.L. 90-542—10/2/68)	USFS	54	—	131	185	55,651
Eleven Point, Mo. (P.L. 90-542—10/2/68)	USFS	—	44.4	—	44.4	14,195
Feather, Calif. (P.L. 90-542—10/2/68)	USFS	32.9	9.7	50.4	93	19,873
Rio Grande, N. Mex. (P.L. 90-542—10/2/68)	BLM/USFS	51.75	—	1	52.75	16,880
	(USFS)	(43.90)	—	(0.25)	(44.15)	
	(BLM)	(7.85)	—	(0.75)	(8.60)	
Rogue, Oreg. (P.L. 90-542—10/2/68)	BLM/USFS	33	7.5	44	84.5	25,999
	(USFS)	(20)	—	(27)	(47)	
	(BLM)	(13)	(7.5)	(17)	(37.5)	
St. Croix, Minn. and Wis. (P.L. 90-542—10/2/68)	NPS/FS	—	181	19	200	62,695
Middle Fork Salmon, Idaho (P.L. 90-542—10/2/68)	USFS	103	—	1	104	32,000
Wolf, Wis. (P.L. 90-542—10/2/68)	NPS	—	25	—	25	5,516
Allagash Wilderness Waterway, Maine (Secretarial Designation—7/19/70)	State of Maine	95	—	—	95	22,840
Lower St. Croix, Minn. and Wis. (P.L. 92-560—10/25/72)	NPS	—	12	15	27	7,845
Little Miami, Ohio (Secretarial Designation—8/20/73)	State of Ohio	—	18	48	66	3,202.5
Chattooga, N.C., S.C., and Ga. (P.L. 93-279—5/10/74)	USFS	39.8	2.5	14.6	56.9	16,424
Little Beaver, Ohio (Secretarial Designation—10/23/75)	State of Ohio	—	33	—	33	2,637.4
Snake, Idaho and Oreg. (P.L. 94-199—12/31/75)	USFS	32.5	34.4	—	66.9	17,546

Rapid, Idaho (P.L. 94-199—12/31/75)	USFS	24	—	—	24	8,382
New, N.C. (Secretarial Designation—4/13/76)	State of North Carolina	—	26.5	—	26.5	1,900
Lower St. Croix, Minn. and Wis. s(Secretarial Designation—6/17/76)	States of Minnesota and Wisconsin	—	—	25	25	6,065
Misouri, Montana (P.L. 94-486—10/12/76)	BLM	72	18	59	149	131,838
Flathead, Mont. (P.L. 94-486—10/12/76)	FS/NPS	97.9	40.7	80.4	219	57,400
Obed, Tenn. (P.L. 94-486—10/12/76)	NPS/State of Tennessee	45.2	—	—	45.2	6,451
	Segments Added In 1978					
Pere Marquette, Mich. (P.L. 95-625—11/10/78)	USFS	—	66.4	—	66.4	13,000
Rio Grande, Tex. (P.L. 95-625—11/10/78)	NPS	95.2	96	—	191.2	30,592
Skagit, Wash. (P.L. 95-625—11/10/78)	USFS	—	99	58.5	157.5	34,650
Upper Delaware, N.Y. and Pa. (P.L. 95-625—11/10/78)	NPS	—	25.1	50.3	75.4	75,000
Middle Delaware, N.Y., Pa., and N.J. (P.L. 95-625—11/10/78)	NPS	—	35	—	35	[b]
American (North Fork), Calif. (P.L. 95-625—11/10/78)	USFS/BLM (USFS) (BLM)	38.3 (26.3) (12)	—	—	38.3	13,430
Missouri, Nebr. and S.D. (P.L. 95-625—11/10/78)	Interior/Corps of Engineers	—	—	59	59	14,941
Saint Joe, Idaho (P.L. 95-625—11/10/78)	USFS	26.6	—	46.2	72.8	21,803
Total		841.15	774.2	702.4	2,317.75	718,756.81

[a] Final boundaries for all areas not established. Thus, figure should be considered approximate.
[b] Located within the Delaware Water Gap National Recreation Area.

Source: U.S. Department of the Interior, Heritage Conservation and Recreation Service.

Figure 6–4

National Wild and Scenic Rivers System, 1979

Source: U.S. Department of the Interior, Heritage Conservation and Recreation Service.

rivers rather than on making use of local zoning laws to protect the areas.

Although agreeing that the Wild and Scenic Waterways System has grown costly, USDA said that the GAO study failed to take inflation and soaring land costs into account. Interior asserted that "river managing agencies [need] to develop and fully take advantage of more cost-effective real estate devices," including scenic easements and sell-back, lease-back arrangements, as well as zoning.[89] However, both Departments stated that they would implement improvements to make the system more efficient.

NATIONAL RECREATION, SCENIC, AND HISTORIC TRAILS

The "Omnibus Parks" Act [90] also established the first new national trails since two initial national scenic trails were created with the passage of the National Trails System in 1968.[91] The 1968 Act established the Appalachian and Pacific Crest Trails and designated 14 other trails for study.

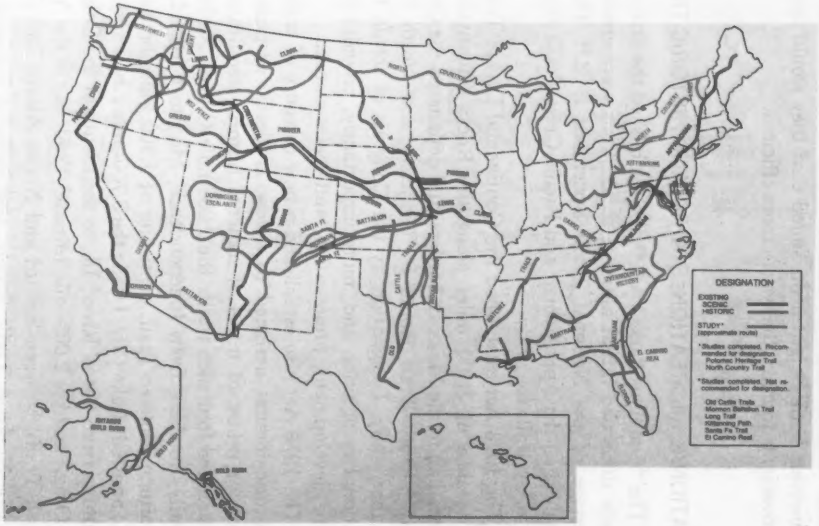
The 1978 Act established the Continental Divide Trail, spanning a distance of 3,100 miles along the Rocky Mountains from the Canadian to the Mexican borders, and designated the Overmountain and Victory Trail Route in Tennessee and North Carolina for further study. Designation by the Congress of scenic trails insures national recognition and, more importantly, provides a vehicle for their development, preservation, and maintenance.

The 1978 Act also established a new category of trails—National Historic Trails—designed to follow as closely as possible original trails or routes of travel of national historic significance. The Act designated four such trails: the 2,000-mile Oregon National Historic Trail, stretching from Independence, Mo., to Portland, Oreg.; the Mormon Pioneer Trail, consisting of 1,300 miles between Nauvoo, Ill., and Salt Lake City, Utah; the 3,700-mile Lewis and Clark Trail, running from Wood River, Ill., to the mouth of the Columbia River in Oreg.; and the 2,000-mile Iditarod Trail, one of the Alaskan Gold Rush Trails, between Seward and Nome, Alaska (see Figure 6–5).

The National Trails System also includes National Recreation Trails. These trails provide for a variety of outdoor uses in or around urban areas. Recreation trails may be managed by public agencies or private organizations. A trail is designated by the Secretary of the Interior or the Secretary of Agriculture and listed in the National Directory of Recreation Trails after assurances are received that the trail will be maintained for at least 10 years. At present there are 275 National Recreation Trails covering a total of nearly 2,900 miles.[92]

Figure 6–5

National Scenic and Historic Trails, 1979



Source: U.S. Department of the Interior, Heritage Conservation and Recreation Service.

NATIONAL PARKS

Major additions were made to the National Park System during 1978, again due to the passage of the "Omnibus Parks" [93] Act. The Act made 12 additions to the National Park System and resolved the controversy over the proposal for a Mineral King Valley ski area near Los Angeles by adding the valley to Sequoia National Park. The other additions to the National Park System are:

- Edgar Allan Poe National Historic Site, Pa.;
- Saint Paul's Church, Eastchester, N.Y.;
- Kaloko-Konokohau National Historical Park, Hawaii;
- Palo Alto Battlefield National Historic Site, Tex.;
- Santa Monica Mountains National Recreation Area, Calif.;
- Ebey's Landing National Historical Reserve, Wash.;
- Friendship Hill National Historic Site, Pa.;
- Thomas Stone National Historic Site, Md.;
- Maggie L. Walker National Historic Site, Va.;
- New River Gorge National River, W. Va.; and
- Jean Lafitte National Historical Park and Preserve, La.

The Act also increased the amount of funds that can be spent on land acquisition for three units of the National Park System and increased the authorized funding limits on development of park facilities for 29 units. It authorized the Department of the Interior to study the following areas for possible addition to the National Park System:

- The Crow Creek Village Archeological Site, S.D.;
- The ridgelands area east of San Francisco Bay, Calif.;
- The Oak Creek Canyon area, Ariz.;
- An expansion of Chiricahua National Monument, Ariz.;
- An update of an earlier study for a national seashore, Guam;
- The Mississippi River Delta Region, La.;
- An extension of the New River Gorge National River, W. Va.; and
- The area from Newport Beach to Laguna Beach, Calif.

The bill further authorized the National Park Service to purchase the concession facilities in Yellowstone National Park from the Yellowstone Park Company. The move is designed to upgrade the accommodations and services for visitors.

The National Park Access Act,[94] signed into law on August 15, 1978, sets up a 3-year pilot program "to make the National Park System more accessible in a manner consistent with the preservation of parks and the conservation of energy." It provides funds for mass transportation demonstration projects for urban visitors to the parks.

WILDLIFE REFUGES

By Executive proclamation on December 1, 1978, the President created two national monuments in Alaska—Yukon Flats (10.6 million acres) and Becharof (1.2 million acres)—which became part

of the National Wildlife Refuge System.[95] Earlier in the year, two areas—Blowing Wind Cave Refuge in Louisiana (193 acres) and Upper Ouachita Refuge in Louisiana (20,900 acres)—were added to the Refuge system under the authority granted the Director of the Fish and Wildlife Service to acquire new lands.

These additions bring the total Wildlife Refuge System to 392 refuges covering 46 million acres (see Figure 6–6 through Figure 6–9). Although the system includes several different types of refuges, mammal and bird refuges and national monuments comprise most of the system.[96]

Several national environmental organizations have criticized the management of the National Wildlife Refuges on grounds that they are being managed principally for the production of game species, and that the production of crops and timber and the grazing of cattle on refuge lands is interfering with the primary purpose of refuges—wildlife protection. In response to these criticisms, Secretary Andrus established a Citizen Task Force on Wildlife Refuge Management. In January 1978, the task force made 26 recommendations intended to insure that all refuges meet certain minimum wildlife management standards and to establish clear guidelines as to which activities can and cannot take place in a wildlife refuge. Secretary Andrus adopted most of the recommendations and directed the Fish and Wildlife Service to take immediate action to implement them.[97] The important new direction insures that management practices on refuges will only be applied for the benefit of wildlife and wildlife habitat. Also, the Secretary directed that the National Refuge System be expanded to accommodate wildlife species other than migratory birds. Such expansion will use easements, leases, and other techniques.

FORESTS

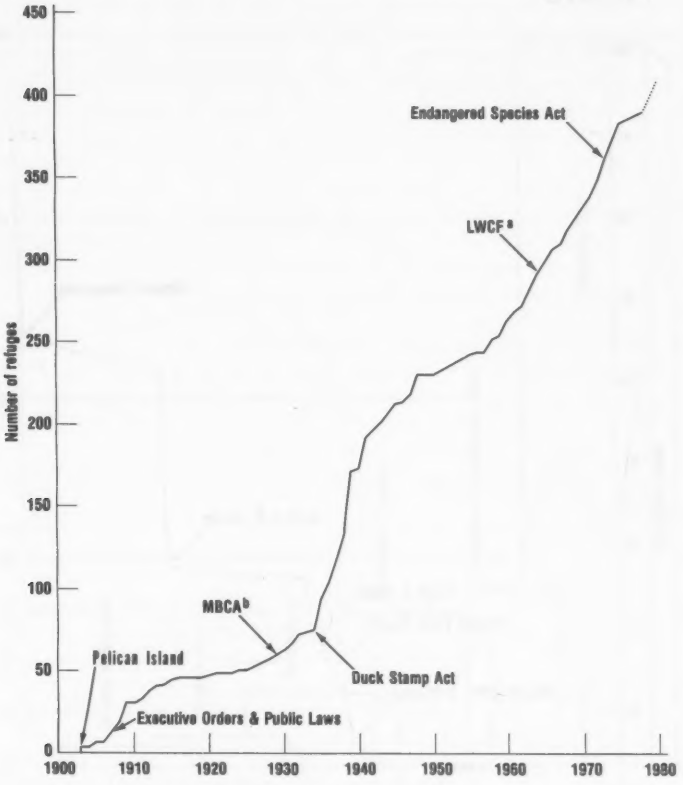
NATIONAL FORESTS AND GRASSLANDS

In May 1979 the Secretary of Agriculture issued for the second time draft land and resource management planning regulations for the National Forest System, required under Section 6 of the National Forest Management Act of 1976.[98] Development of these regulations drew renewed attention to many of the issues involved in the use and management of forest lands. The Secretary established a committee of scientists to provide scientific and technical advice and counsel on proposed guidelines and procedures to insure that an effective interdisciplinary approach was proposed and adopted. The committee considered all aspects of Sections 6 and 13 and held meetings throughout the nation that were open to the public to address these issues.

These process-oriented regulations establish comprehensive procedures by which the Forest Service will conduct land and resource management planning on the National Forest and National Grasslands. They replace procedures that allowed separate single-purpose

Figure 6–6

Growth in National Wildlife Refuge System, 1900–78



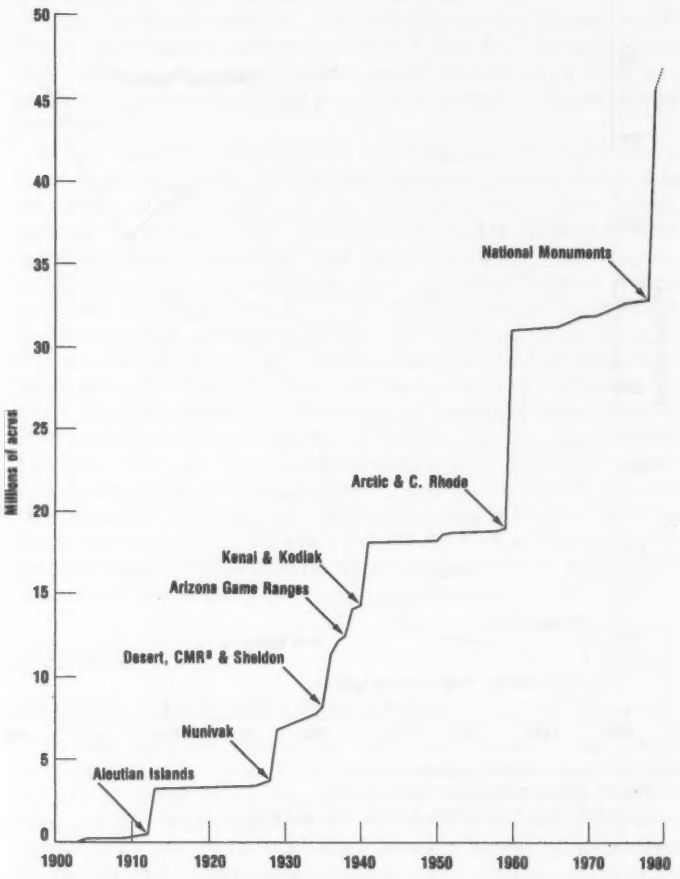
[a] LWCF = Land Water Conservation Fund.
[b] MBCA = Migratory Bird Conservation Act.
Source: U.S. Department of the Interior, Fish and Wildlife Service.

planning (for example a plan for timber, a plan for wildlife, etc.) with a single comprehensive and integrated blueprint for the management of an entire National Forest. In the past, planning was done on a local basis, with great latitude to focus on local issues rather than national needs. Now the Forest Service must use the regulations to prepare new land and resource management plans that not only respond to local concerns, but also provide for national requirements. These plans will be completed for all forests and grasslands by 1985.

One of the most important and controversial sections of these regulations sets out the type of limitations that would be placed on timber

Figure 6–7

Growth in Acreage of National Wildlife Refuge System, 1900–78



[a] CMR = Charles M. Russell Refuge.

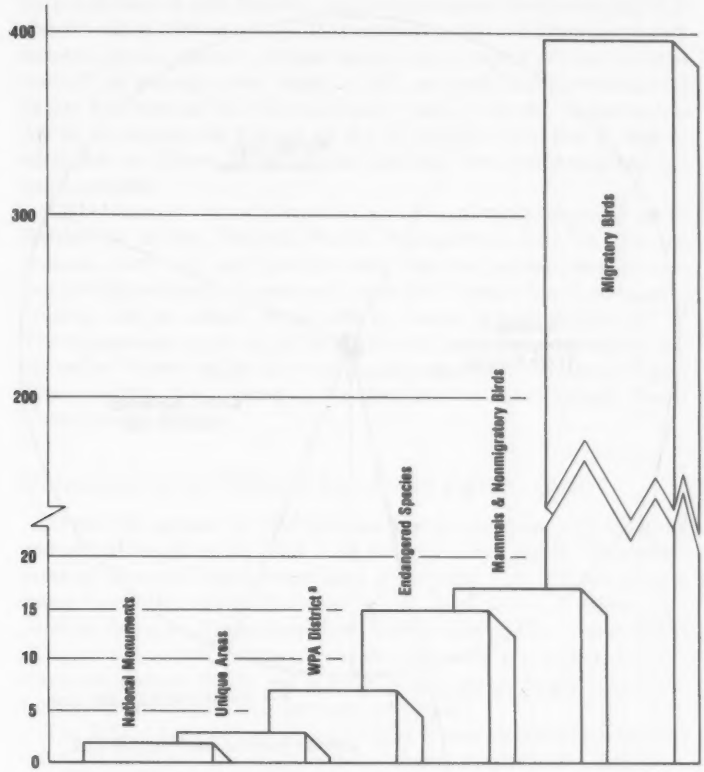
Source: U.S. Department of the Interior, Fish and Wildlife Service.

removal. Section 13(a) of the National Forest Management Act requires the Secretary of Agriculture generally to limit the amount of timber harvested on each National Forest to a "quantity equal to or less than a quantity which can be removed from such forest annually in perpetuity on a sustained-yield basis." [99]

However, Section 13(a) also allows the Secretary to sell more timber for "any decade" than the sale quantity established under

Figure 6–8

Numbers, by Type, of National Wildlife Refuges, 1978

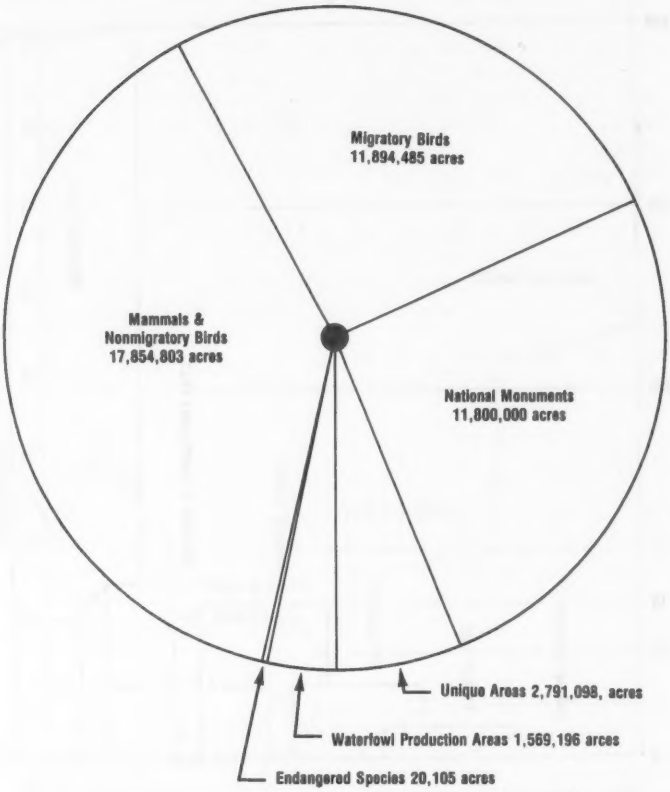


[a]WPA = Waterfowl Production Area.
Source: U.S. Department of the Interior, Fish and Wildlife Service.

even-flow management "to meet other multiple-use objectives." This is called a departure from nondeclining even flow. The management and removal of timber from public lands is directed by a complex set of laws and procedural guidelines. These laws and guidelines limit the range of actions that can be taken by a public forest manager. The Multiple-Use Sustained Yield Act of 1960 requires that the national forest be administered for a variety of purposes ". . . and not necessarily the combination of uses that will give the greatest dollar return or the greatest unit output." [100] The present policy of the USDA is to limit annual timber sales on each national forest to levels that can be sustained in perpetuity.

Figure 6–9

Acreage, by Type, of National Wildlife Refuges, 1978



Source: U.S. Department of the Interior, Fish and Wildlife Service.

In order for the Forest Service to consider options to depart from nondeclining flow management, this issue must be addressed in the new resource management planning process, and discussed in environmental impact statements. A decision to depart from nondeclining flow would have to be consistent with multiple-use objectives established in the forest plans prepared for the affected forest and approved by the Chief of the Forest Service. Normally the planning process can take up to 3 years to complete.

In an effort to insure that departure options are considered, the President in June 1979 instructed the Secretaries of Agriculture and Interior ". . . to take steps consistent with existing law and environmental considerations to increase timber supplies through a limited

and temporary departure from the current nondeclining even-flow policy of harvesting timber from Forest Service and Bureau of Land Management lands." [101] A purpose of this policy directive is to help slow inflation in new housing costs by increasing timber supply that should reduce timber prices. It is estimated that a billion board-foot increase in the nation's annual timber supply would reduce the total cost of an average new house by 0.6 percent. The expectation of future increases of federal timber sales could cause the timber industry to accelerate the harvest of the 28 billion board-feet inventory of timber on Forest Service lands that has been purchased but not yet harvested.

USDA has also issued a separate set of regulations, required under Section 11 of the National Forest Management Act, "to give the federal, state, and local governments and the public adequate notice and opportunity to comment upon the formulation of standards, criteria, and guidelines applicable to Forest Service programs." [102] The regulations apply to all Forest Service programs in research, cooperative forestry assistance, and management of the National Forest System which are covered under Section 6 of the National Forest Management Act.

MANAGEMENT OF PRIVATE AND STATE FOREST LAND

About 80 percent of the nation's forest lands are not federally owned. Although some land is in state or other public ownership, most of this nonfederal forest land is privately held. Of the private forest lands, the largest share belongs to small farms or other small rural landowners. These nonfederal forest lands produce a significant share of the nation's timber, provide watershed protection, support large populations of fish and wildlife, and produce significant opportunities for recreation and aesthetic enjoyment.

The USDA has conducted cooperative forestry assistance programs since 1911. These efforts have been aimed at protection, improvement, and use of the resource values of these lands. One area in which federal and state efforts have produced significant results is in controlling damage from fire. Since 1924, there has been an approximate 90 percent reduction in losses to fires on land protected under fire protection programs—from 93,112 acres burned per million acres protected in 1924 to 1,208 acres burned per million acres protected in 1978. In addition, through cooperative programs, 650 million tree seedings have been planted on half a million acres. Due to improved utilization of harvested trees, waste has been reduced by an estimated 46 percent, and more wood is being used for energy.

On July 1, 1978, the President signed the Cooperative Forestry Assistance Act [103] providing for important new coordination of cooperative forestry activities and enhancement of environmental quality on the millions of nonfederal forested acres. Under the Act, funds can be appropriated to rural forestry projects, as well as to planning efforts as provided under the previous authorizations.

An increasingly important national problem in the future may be overcutting of privately held forest land, particularly land held by large companies. A study released in January 1979 by the Library of Congress concluded that the Forest Service, farm, and other small rural landowners appear to be cutting their softwood timber at a rate closer to a long-term sustained yield level than timber companies.[104]

This conclusion is based on Forest Service data on national changes in softwood timber growth, mortality, and harvest over a 25-year period from 1952 to 1977. The report compares the amount of growth for each type of landowner to the amount of timber cut. In 1952, for farm and other private ownerships, which included 58 percent of the total U.S. forest land acreage, the softwood timber cut exceeded growth by 3 percent. Yet, in 1977, despite a 2.5 percent reduction in the amount of land in the farm and other private ownerships category, the relationship was reversed: growth exceeded cut by 65 percent.

In contrast, the timber industry land has shown a softwood growth deficit over the past 25 years. In 1952, the softwood cut exceeded growth by 32 percent. In 1977, even though the timber industry's land holdings had increased by 14 percent since 1952, the softwood timber cut still exceeded growth by 21 percent.

RANGELANDS

Historically, the millions of acres of federally owned rangelands covering large portions of the western states have suffered from a lack of national attention and an absence of consistent management. In the past, the nation was primarily concerned with settling the West and exploiting its resources. There is now national support for retaining the public lands in public ownership and managing them for the benefit of all on the basis of sustained yield. This philosophy was enunciated in the Federal Land Policy and Management Act of 1976,[105] which requires orderly land use planning for each rangeland area. The Public Rangelands Improvement Act of 1978[106] further emphasized the concern of Congress by authorizing a substantial funding increase to improve the condition of the nation's public rangelands.

ENVIRONMENTAL REVIEW

Impatience with BLM's slow progress in improving the management and condition of the public rangelands led the Natural Resources Defense Council (NRDC) to sue the agency.[107] In 1974 NRDC obtained a court order that required BLM to prepare environmental impact statements analyzing the impacts of livestock grazing on its lands. The environmental analysis process has required BLM to describe objectively the condition of the public rangelands,

thus increasing public awareness and strengthening Congressional support for better management practices. BLM now believes that better inventories of the basic resources of the public rangelands, including soils, vegetation, watershed conditions, wildlife habitat, etc., are still needed so that more effective land use plans can be developed.

By 1978, BLM had completed 10 EISs covering 7,197,000 acres of BLM land. Twelve more covering 12,750,000 acres are to be finished by September 30, 1979. The remaining 153,600,000 acres are to be evaluated in 122 EISs by the end of 1988. It is evident from the analysis in the EISs completed thus far that positive actions are necessary to halt further deterioration of these rangelands and to provide for their ultimate improvement. BLM is now beginning to improve rangeland conditions through scientific management of the vegetative cover, careful management of livestock use, and investments in range improvements.

USDA, DOI, and CEQ sponsored a symposium on the need for new rangeland policies in January 1979.[108] The symposium brought together policymakers, scientists, educators, livestock operators, and environmentalists to discuss the technical dimensions of rangeland conditions, competing demands for this valuable resource, opportunities to improve rangelands, and other technical issues surrounding vegetative management practices.

GRAZING FEES

The Public Rangelands Improvement Act of 1978 [109] also mandated that a new formula be used in calculating grazing fees for federal land for the period 1979 through 1985. It further stipulated that studies be done leading to recommendations on fees to be charged beginning in 1986. As a result, grazing fees have increased from $1.51 per animal unit month (AUM) (the equivalent of one animal grazing for one month) to $1.89 per AUM. Fifty percent of all money collected from grazing fees is used to finance range improvement practices.

OFF-ROAD VEHICLES

Off-road vehicles—particularly motorcycles, dune buggies, and jeeps—have continuing serious adverse impacts on public lands. The 1972 Executive order,[110] which was designed to limit the areas of off-road vehicle (ORV) use on public lands, was amended in 1977 [111] to mandate closing public lands to ORVs where they "will cause or are causing considerable adverse effects on the soil, vegetation, wildlife population, and other values." However, serious conflicts continue to exist between ORV users and desert homesteaders, hikers, scientists, and environmentalists.

The adverse effects from ORVs occur not only in the West, with its particularly fragile arid land ecosystems, but in forests, prairies, tundra, and mountains throughout the United States. Those conflicts and the federal response to this problem are examined in detail in a report written for CEQ this year entitled *Off-Road Vehicles on the Public Land.*[112]

As the report points out, some agencies have encountered more difficulty than others in carrying out these Executive orders. Although the Forest Service has ORV management plans for 150 of its forests, the Sierra Club Legal Defense Fund contested eight of these plans as being inconsistent with the Executive orders.[113] Four of these appeals have thus far been rejected by the Chief of the Forest Service.[114]

However, the Forest Service is working on a new policy to conform to the amended Executive order.[115] When this new policy is completed in mid-1979, all National Forest ORV plans will be reviewed.

Although BLM released a set of regulations in July 1978[116] for managing and controlling ORVs, it is moving slowly to implement them. The regulations provide for a process to designate BLM land as "open," "restricted," or "closed" to ORV use, but this designation process will not be completed until 1987. In the meantime, currently undesignated lands remain open to ORV use.

Concern is growing over the damage ORVs are doing to intaglios in Arizona and southern California. Intaglios are large human and animal figures carved into the earth by ancient peoples and held sacred by them. These rare archeological figures exist in only two places in this hemisphere—Peru and the U.S. Sonoran Desert. Associated with the intaglios are rock carvings called petroglyphs. There are at least 29 known site concentrations—containing approximately 150 individual intaglios and less than 100 major petroglyph loci—all of which are on BLM-administered land.

Only four of these intaglio sites have been fenced in, and at one of the four, the famous Blythe intaglio, a portion of the fence was broken through 8 years ago and has not yet been repaired. The rest of the unprotected sites are constantly endangered by ORV use, and particularly so by the Parker 400, an annual BLM-authorized ORV race. On February 10, 1979, vehicles in this race passed within 60 feet of the unprotected thunderbird intaglio. BLM has stated that their cultural resource inventory and protection program in this area is subject to funding and manpower limitations; however BLM district offices are now working with a citizens group that has offered to build fences to BLM standards with materials supplied by the agency.

NONFUEL MINERALS

OVERVIEW OF ENVIRONMENTAL ISSUES

Industrial growth in the United States during this century has been sustained in part by a wide variety of high-quality mineral

resources. As shown in Tables 6–8 and 6–9, consumption of major nonfuel minerals has increased substantially during the past 30 years, although the rates of increase have declined in the past decade.

In addition to those minerals used for energy (coal, oil, gas, and uranium) about 100 other mineral commodities are consumed in agriculture, manufacturing, and other basic industries. More than 2 billion tons of nonfuel minerals were consumed in 1977 by the chemical, machinery, electrical, construction, and transportation industries.[117] The United States produces about one-quarter of the world's raw and processed mineral commodities; nevertheless we must import several essential commodities, including cobalt, chromium, and platinum.

Although adequate, reliable supplies of mineral commodities continue to be essential to the overall economy and security of the United States, the mining and processing of these minerals has resulted at certain times and in certain locations in severe adverse effects on the land, on air and water quality, and on human health and safety. A large amount of land has been directly disturbed by surface and open-pit mining operations. A study by the Bureau of Mines revealed that in the period between 1930 and 1971 approximately 1.5 million acres were altered by coal surface mining, two-thirds of which has undergone some reclamation, whereas more than 2 million acres were disturbed by the mining of other minerals, of which only about one-fifth have been reclaimed (see Table 6–10).

Specific environmental impacts of phosphate mining were discussed in last year's Annual Report;[118] adverse impacts associated with the mining and processing of other minerals include the following:[119]

- Open-pit copper mining generates more than 40 percent of all U.S. mine wastes and overburden—this amounted to 686 million tons in 1975. Such mine tailings often contain high concentrations of lead and other toxic metals. Waste generation is expected to increase due to decreasing copper content of the ores.
- Mining and processing of iron and steel produces more than 500 million tons of solid wastes per year. The industry also discharges 14 percent of all industrial particulate emissions and 30 percent of all industrial processing wastewater.
- Lead mining and processing produces more than 8 million tons of toxic tailings annually, and also releases several hundred tons of lead emissions into the atmosphere. In addition, acid mine drainage from underground lead mines can contaminate water supplies and streams with toxic chemicals.
- The mining and processing of asbestos and asbestos-containing products creates major health problems from exposure to asbestos fibers, which can cause asbestosis and several forms of cancer.

Reclamation efforts are now underway for much of the land that has been or is being surface mined for coal, in accordance with the federal Surface Mining and Reclamation Act of 1977 (see Chap-

Table 6–8

Trends in U.S. Consumption of Major Nonfuel Minerals, 1948–78

Mineral	Quantities Consumed (millions of tons per year except as noted)				Percent Growth			
	1948	1958[a]	1968	1978	1948–78	1948–58	1958–68	1968–78
Ferrous metals [b]	62.9	71.5	107.3	115.0	83	14	50	7
Aluminum	0.8	2.2	4.7	6.0	650	175	114	28
Copper, lead, and zinc	3.4	4.0	5.2	5.0	47	18	30	−4
Building materials [c]	580.1	1,291.0	1,812.8	2,020.6	248	123	40	11
Other nonfuel minerals [d]	31.9	49.4	91.0	106.8	235	55	84	17
Gross national product (billions of 1972 dollars)	487.7	697.3	1,051.8	1,385.3	184	43	51	32
Population (millions)	146.6	174.9	200.6	218.4	49	19	15	9

[a] 1958 figures are annual averages of 1956 through 1960.
[b] Steel mill shipments plus imports net of exports.
[c] Sand and gravel, crushed stone, and cement.
[d] Phosphate rock, lime, and salt.

Source: Resource Conservation Committee staff, based on statistical sources listed under Table 6–9.

Table 6–9

Trends in U.S. Material and Energy Use Relative to Total National Product and Population, 1948–78

Mineral	Tons Consumed Per Million Dollars of Gross National Product (1972 dollars)			
	1948	1958	1968	1978
Ferrous metals	128.9	102.5	102.0	83.0
Aluminum	1.6	3.1	4.4	4.3
Copper, lead, and zinc	7.0	5.7	4.9	3.6
Building materials	1,189.4	1,851.4	1,723.5	1,458.6
Other nonfuel minerals	65.4	70.8	86.5	77.1
Lumber, plywood, and veneer [a]	12.3	8.95	7.3	6.3
Pulp, from roundwood	30.8	29.3	26.7	22.0
Coal	1,089.0	525.9	474.2	446.1
Petroleum [b]	4,335.0	4,754.0	4,553.0	4,924.0
Natural gas [c]	10,140.0	15,430.0	18,500.0	14,010.0
	Pounds Consumed Per Person			
	1948	1958	1968	1978
Ferrous metals	858.1	817.6	1,069.8	1,053.1
Aluminum	10.9	25.2	46.9	54.9
Copper, lead, and zinc	46.4	45.7	51.8	45.8
Building materials	7,914.0	14,762.7	18,073.8	18,503.7
Other nonfuel minerals	435.2	564.9	907.3	978.0
Lumber, plywood, and veneer [d]	40.9	35.7	38.3	39.8
Pulp, from roundwood	204.6	233.3	280.2	279.3
Coal	7,245.6	4,193.3	4,973.1	5,659.3
Petroleum [e]	605.6	796.0	1,002.7	1,307.7
Natural Gas [f]	33.7	61.5	97.0	88.9

[a] Thousand cubic feet of roundwood per million dollars.
[b] Barrels per million dollars.
[c] 1,000 cubic feet per million dollars.
[d] Cubic feet of roundwood per person per year.
[e] Gallons per person per year.
[f] 1,000 cubic feet per person per year.

Sources: Resource Conservation Committee Staff, based on U.S. Department of the Interior, Bureau of Mines Mineral Commodity Summaries 1979 and *Mineral Yearbook* of 1948, 1958, and 1968; U.S. Department of Agriculture, Forest Service, *The Demand and Price Situation for Forest Products*, 1975–76; U.S. Department of Energy, Energy Information Administration, *Monthly Energy Review*, March 1979.

ter 5).[120] This is not, however, the case with lands mined for nonfuel minerals. There are no federal requirements for the reclamation of such lands, and state laws and regulations, where they exist, usually vary from one mineral to another, as well as from one state to the next. The states most heavily affected by surface mining of nonfuel minerals during the period 1930 to 1971 are shown in Table 6–11.

In April 1979 the Office of Technology Assessment issued a comprehensive report on the management of minerals and mining on public lands.[121] This report notes that the acreage figures as given in Table 6–11 do not include certain impacts on land and waters beyond the site of the developed mines—such as exploratory activities, mills, and processing plants; development of mining towns and access roads; pollution of surface and ground water resources; or effects on wildlife or recreation adjacent to mine sites.

Table 6–10

Land Disturbed by Surface and Open-Pit Mining, 1930-71

Mineral	Acres disturbed
Coal	1,500,000
Sand & Gravel	660,000
Stone	516,000
Miscellaneous Commodities	480,000
Clays	167,000
Copper	166,000
Iron Ore	108,000
Phosphate Rock	77,300
Uranium	12,800

Source: U.S. Department of the Interior, U.S. Bureau of Mines, *Land Utilization and Reclamation in the Mining Industry, 1930–1971*, (Washington, D.C.: U.S. Government Printing Office, 1974).

The National Academy of Sciences (NAS) study, due to be finished in October 1979, focuses on the environmental effects of mining minerals other than coal and on the technical feasibility of reclamation operations. The study is intended to: (1) assess for noncoal minerals the degree to which the requirements of the Surface Mining Control and Reclamation Act [122] can be met by existing and developing technology, the costs involved, and the specific areas where technology cannot meet these requirements; and (2) discuss alternative regulatory mechanisms to achieve the most beneficial post-mining land use for areas affected by surface and open-pit mining. After the study is completed, CEQ will prepare specific legislative recommendations to be submitted to the President and the Congress.

NONFUEL MINERALS DOMESTIC POLICY REVIEW

Responding to the concerns of several members of Congress and his Administration about the price and availability of nonfuel minerals, President Carter, in December 1977, authorized a review of nonfuel minerals marketing and regulatory policies. The Nonfuel Minerals Policy Review includes consideration of environmental quality, health, and safety in relation to the price and availability of minerals. The study was designed to achieve two primary objectives: (1) to submit for Presidential consideration appropriate policy options and recommendations on current and anticipated problems related to nonfuel minerals, and (2) to develop a policy analysis process (a framework) that federal decisionmakers can use to assess mineral-related problems in the future.

The draft problem analysis report (prepared at the direction of the Domestic Policy Staff and the Cabinet-level Policy Coordinating Committee) was circulated in July for interagency review and released in August for a 30-day public comment period. The draft report identified several major issues that were recommended for further study.[123] These issues include the following:

Table 6–11

Acres of Land Utilized for Mining Selected Commodities in Leading Mining States, 1930–71

State	All Commodities (except coal)	Copper	Iron	Phosphate	Clay	Uranium	Sand and Gravel	Stone
California	226,970		2,720		10,400	5	81,000	31,300
Minnesota	136,000		80,300		560		28,400	3,880
Pennsylvania	134,000		770		11,700		16,500	6,260
Arizona	101,780	84,000	5		620		10,800	2,140
Michigan	98,940	4,800	4,470		6,700		40,500	33,200
New York	96,300		1,830		4,670		30,600	28,300
Florida	88,800			47,900	1,710		5,970	22,100
Ohio	85,000				17,300		31,300	35,500
Texas	77,230	5	1,010		11,600	240	27,400	28,800
Utah	63,480	38,900	3,310	1,530	840	20	8,990	2,560
Illinois	63,000				7,880		31,700	21,900
Tennessee	49,900	940	30	16,200	4,420		6,420	19,100
Wisconsin	49,900		1,740		440		29,900	14,000
Iowa	46,700				3,390		14,000	25,200
Idaho	41,290	30	5	8,220	120	5	7,350	2,070
Nevada	41,100	12,800	540		30	10	5,830	1,360
Colorado	40,170	30	50		1,590	330	14,700	5,630
New Mexico	39,540	13,000	30		230	6,670	6,950	1,690
Montana	35,980	10,900	10	2,660	300	5	12,300	3,310
Georgia	34,260		370		13,700		2,580	15,000
Washington	34,530	110	5		890	350	20,500	10,400
Alabama	30,200		7,540		6,390		5,280	10,700
Wyoming	18,200		1,430	650	3,900	4,300	5,640	1,850

Source: Bureau of Mines Information Circular 8642 (1974), *Land Utilization and Reclamation in the Mining Industry, 1930–71*, Table 9, p. 20.

- Federal government planning and decisionmaking involving nonfuel minerals is uncoordinated. There is no formal process of effective participation by nonfuel mineral policymakers in developing broader national goals that significantly affect minerals supply and consumption.
- The data gathering and analysis capability required to support nonfuel mineral policymaking in the federal government is deficient or nonexistent. There are serious deficiencies in agency forecasting and environmental impact data-gathering and analysis capabilities.
- Efforts to control environmental pollution problems associated with the mining and processing of nonfuel minerals have been successful in limiting some pollutants. Other problems are not adequately regulated. In some cases, the most cost-effective pollution control solutions may not be achieved.
- Current federal nonfuel minerals research and development programs may not be adequate to address the current and future generic national problems that confront the U.S. minerals industry.

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CHAPTER 7

ECOLOGY AND LIVING RESOURCES: COASTAL ECOLOGY AND SHELLFISH

Coastal waters—bays, estuaries, and the near-shore ocean—are the nexus of several major natural systems. They directly abut the land and are affected by activities there—not only on coastal lands in the immediate vicinity, but also on land great distances away. Discharge of pollutants from coastal sewage treatment plants and industrial facilities, for example, will affect the quality of coastal waters. Equally important, erosion many hundreds of miles upstream can cause the silting-up of harbors, and chemical pollutants released upstream will accumulate in the sediments of estuaries.

The ocean in turn affects the land at the coast, sometimes causing major alterations, as during a hurricane. Oceanborne pollution, such as an oil slick, may also come to rest there.

Even the atmosphere, by depositing air-borne chemicals both into freshwater that drains into coastal waters and into the ocean itself, contributes to the condition of the coastal waters, making them the locus of complex chemical and physical processes.

Human activities have a profound impact on this complex system in ways that are sometimes difficult to unravel and often unexpected. In natural systems relatively unperturbed by man, such as the Apalachicola Bay discussed in the next section, the in-shore fauna relies on nutrients derived from the land. If the flow of nutrients is increased (by agricultural runoff, for example) or decreased because of diversion of nutrient-containing freshwater, then the biota will be affected. Conversely, if toxic materials are received by coastal waters, there may be immediate or long-term effects to the ecosystem. As this chapter will show, every year a large inventory of heavy metals drains by river and stream from land to the coastal waters.

Among the great variety of living organisms that inhabit coastal waters, one of the more sensitive to environmental conditions is the group of shellfish called molluscs, which include oysters, clams, and mussels. Molluscs often accumulate toxic materials from the environment in their tissues. The Environmental Protection Agency (EPA) has been making nationwide surveys of such accumulation for 4 years. The results of this program indicate the probable existence of water quality problems at a number of sites that had not been detected by other means and that merit investigation.

Molluscs, by their numbers and health, also reflect other forces at work on the coastal zone, some of them quite detrimental to the zone's ecological balance. Because shellfish harvests have been recorded for decades, knowledge of long-term trends in these populations is detailed. Many of these fisheries have shown dramatic declines. Pollution, alteration of habitat, overfishing, and natural changes have all been involved. It is difficult to sort out their relative importance. However, evidence is accumulating that pollution and alteration of habitat, resulting from human activities both in the coastal region and inland, are adversely affecting the health of valuable coastal ecosystems.

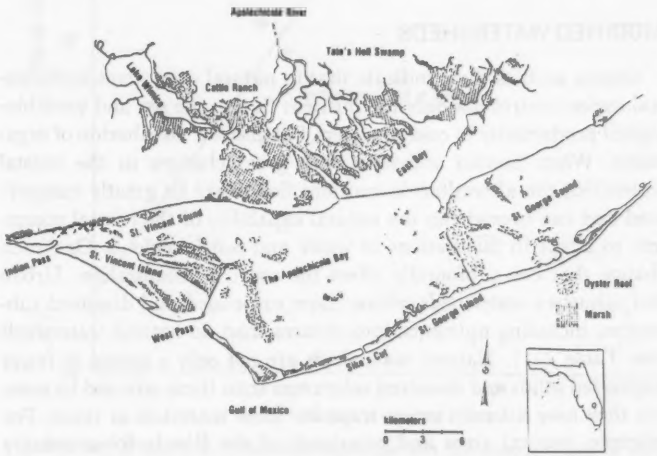
EFFECTS OF WATERSHEDS ON COASTAL ECOLOGY

NATURAL WATERSHEDS

In natural circumstances, events far inland can have a marked effect on the biological processes occurring at the coast. For example, researchers from Florida State University found that fisheries in the Apalachicola Bay depend on the transport of food and chemical nutrients from the land to the bay via the Apalachicola River. The Apalachicola drainage system is extensive, including portions of Alabama, Georgia, and Florida (see Figure 7–1).

Figure 7–1

The Apalachicola Bay System



Source: R. J. Livingston, P. S. Sheridan, B. G. McLane, F. G. Lewis, III, and G. G. Kobylinski, "The Biota of the Apalachicola Bay System: Functional Relationships," Florida Marine Research Publications, No. 26 (April, 1977), p. 76.

The Apalachicola estuary is a shallow brackish body of water lying behind barrier islands and reefs that is fed large quantities of freshwater by the Apalachicola River. The estuary varies seasonally in salinity, turbidity, color, and detritus deposition, in direct relation to river flow. (Detritus is defined here as dissolved or particulate organic substances suspended in waterways.) The bay is relatively unpolluted and is naturally high in algal productivity and fish, including anchovies, oysters, blue crabs, and shrimp.

The bay's exceptional fecundity depends to a considerable degree on organic matter and inorganic salts brought by the river from upland areas. Thousands of tons of detritus, such as leaf litter and wood debris, are swept into the bay each year by the Apalachicola River. Small organisms consume the detritus or use it as shelter. These small creatures, in turn, serve as food for the larger and commercially important animals in the bay.

The impact of river flow on the fisheries was demonstrated in an analysis of 58 years of river flow and rainfall data from various parts of the Apalachicola drainage basin. Rainfall in the upper reaches of the watershed, hundreds of miles away, strongly affects the flow of nutrients into the bay. Both rainfall and river flow patterns follow a 6- to 8-year cycle. Both are positively correlated with commercial fishery catches in north Florida, including major commercial species such as blue crabs, penaeid shrimp, and oysters.[1]

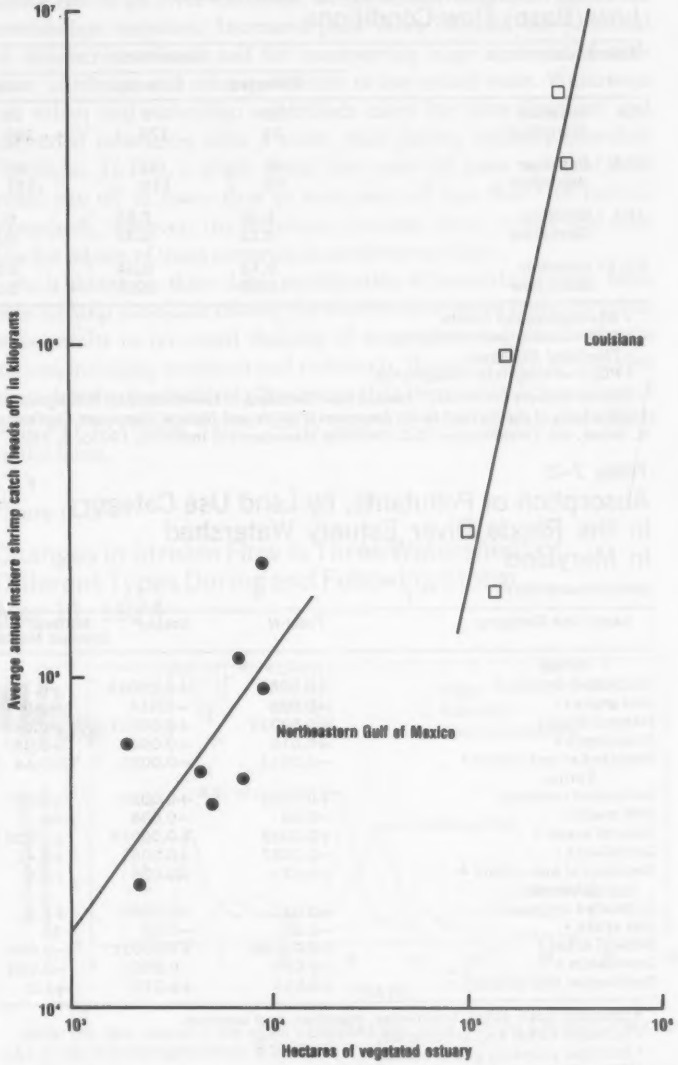
Likewise, portions of the Gulf that receive runoff from wetland areas are far more productive in terms of shrimp catches than are other areas (see Figure 7–2).

MODIFIED WATERSHEDS

Studies such as these indicate that in natural ecosystems hydrological cycles control not only the nutrient flux to the sea and total biological productivity in coastal waters, but also the distribution of organisms. When human activities work great changes in the coastal watershed, the alterations in nutrient flows may be greatly exaggerated and can overwhelm the natural capability of the coastal ecosystem to adapt to fluctuations in water and nutrient flows. One such change that can profoundly affect the coast is urbanization. Urban and suburban watersheds release more suspended and dissolved substances, including nutrients, into streams than do natural watersheds (see Table 7–1). Natural watersheds are not only a source of fewer suspended solids and dissolved substances than those affected by man, but they may actually act as traps for these materials at times. For example, natural areas and grasslands of the Rhode River estuary watershed in Maryland absorb mineral suspended matter during the summer, and the grassland areas absorb both nitrogen and phosphorus in the spring and summer (see Table 7–2).

Figure 7–2

Shrimp Yields in Relation to Area of Vegetated Estuary



Source: Turner, R. E., "Intertidal Vegetation and Commercial Yields of Penaeid Shrimp," *Transactions of the American Fisheries Society*, 106(5): 411–416 (September, 1977), p. 414.

Table 7–1

Comparison of Mean Concentrations (mg/l) for Stream Water Constituents in Three North Florida Watersheds During Storm and Low (Base) Flow Conditions

Constituent		Watershed		
		Forested	Suburban	Urban
SS[a]	Baseflow	12	7	10
	Stormflow	34	176	299
TDS[b]	Baseflow	43	53	86
	Stormflow	58	115	161
TN[c]	Baseflow	0.10	0.25	0.17
	Stormflow	0.12	0.42	0.29
PO_4 P[d]	Baseflow	0.13	0.04	0.06
	Stormflow	0.10	0.05	0.12

[a] SS=Suspended Solids.
[b] TDS=Total Dissolved Solids.
[c] TN=Total Nitrogen.
[d] PO_4-P=Phosphate-Phosphorus

Source: Robert C. Harriss, "Toward New Concepts in Environmental Management," *Transactions of the Fortieth North American Wildlife and Natural Resources Conference*, K. Sabol, ed. (Washington, D.C.: Wildlife Management Institute, 1975), p. 360.

Table 7–2

Absorption of Pollutants, by Land Use Category, in the Rhode River Estuary Watershed in Maryland

(pounds/acre/day)

Land Use Category	Total-N	Total-P	Mineral Suspended Matter
Winter			
Cultivated cropland	+0.0052	+0.00036	+0.31
Wet areas [a]	−0.095	−0.014	−4.6
Natural areas [b]	+0.00033	+0.00021	+0.088
Grasslands [c]	+0.016	+0.0020	+0.087
Residential and others [d]	−0.0034	−0.0025	+0.44
Spring			
Cultivated cropland	+0.0080	+0.0026	+0.80
Wet areas [a]	−0.38	−0.088	−26
Natural areas [b]	+0.0029	+0.00054	+0.026
Grasslands [c]	−0.0087	−0.0051	+0.41
Residential and others [d]	+0.031	+0.026	+3.3
Summer			
Cultivated cropland	+0.023	+0.0098	+1.4
Wet areas [a]	−0.36	−0.16	−36
Natural areas [b]	+0.00085	+0.00021	−0.080
Grasslands [c]	−0.014	−0.0098	−0.023
Residential and others [d]	+0.014	+0.018	+1.2

[a] Includes open water, freshwater, marshes, and swamps.
[b] Includes forest and brushlands.
[c] Includes primarily pastureland.
[d] Others include bare areas, paved areas, dumps, roads.

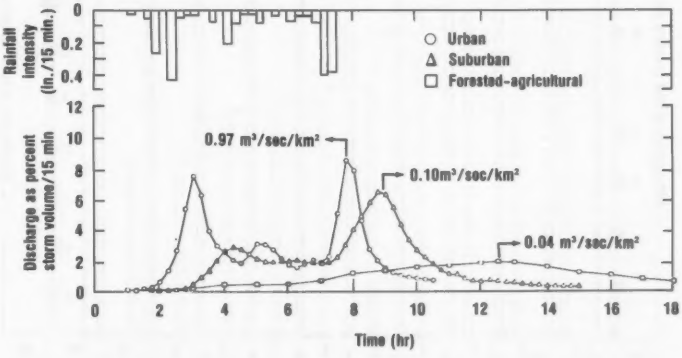
Source: David L. Correll, "The Rhode River Program," *Proceedings of a Conference on Estuarine Pollution Control and Assessment, Volume II*, U.S. Environmental Protection Agency, Office of Water Planning and Standards (Washington, D.C.: U.S. Government Printing Office, 1975), p. 21.

In addition, in an urbanized watershed, peak flows after a heavy rain are very high and pass quickly (see Figure 7–3). A forest-agricultural watershed by contrast exhibits a slow, relatively long-lasting rise in its river discharge. A surburban watershed shows an intermediate response. Increased peak flows increase the potential for downstream floods and for transporting large amounts of sediment, nutrients, and other pollutants to the coastal zone. Waterways and urban and surburban watersheds carry far more dissolved and suspended substances after a storm than during ordinary base-flow conditions. In fact, a single storm may carry off more material than would run off in many days or even years of base flow.[2] In natural watersheds, however, the difference between storm runoff and base flow for release of these materials is moderate or slight.

As is shown by these data, modification of watersheds away from their natural condition toward the kind of watersheds found in urban areas results in increased flushing of suspended and dissolved substances, including nutrients and pollutants. Research such as that performed in the Apalachicola Bay shows that these substances will wend their way to coastal waters where they will have measurable effects on the biota.

Figure 7–3

Changes in Stream Flow in Three Watersheds of Different Types During and Following Storm, May 11, 1974



Note: The total rainfall in the urban watershed was 5.49 cm; in the suburban, 4.98 cm; and in the forested-agricultural, 6.27 cm.

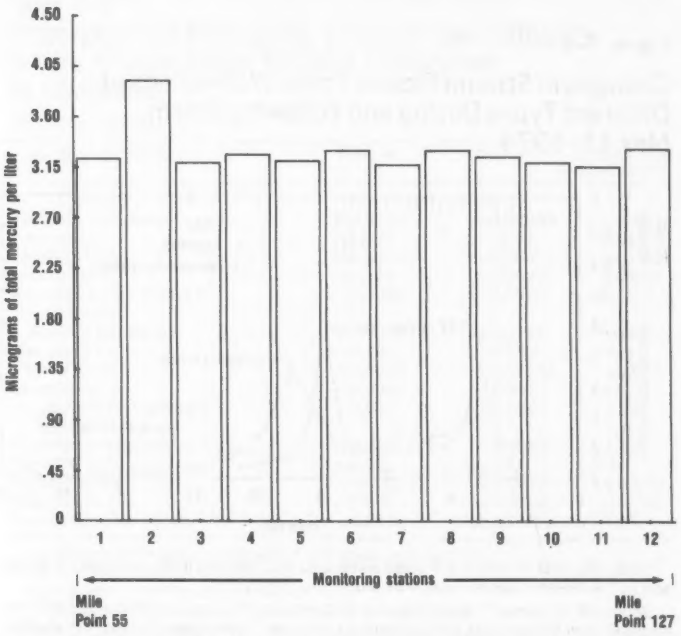
Source: R. R. Turner, T. M. Burton, and R. C. Harriss, "Descriptive Hydrology of Three North Florida Watersheds in Contrasting Land Use," *Watershed Research in Eastern North America*, Volume I, D. L. Correll, ed. (Edgewater, Md.: Chesapeake Bay Center for Environmental Studies, Smithsonian Institute, 1977), p. 221.

TRANSPORT OF POLLUTANTS

Nearly all precipitation that does not evaporate is eventually transported in underground aquifers or in streams and rivers to the sea. But rain is not chemically pure water. A variety of gases, liquids, and solids (such as sulfates)—some natural (such as dust), and some of human origin—are collected by precipitation as it falls to the ground. More chemicals and sediment are picked up by the water as it moves across and through the ground to the surface streams or aquifers, due to dissolution of soil minerals and to physical erosion of the soil. Surface waters, especially because of the volume of their flow and ease of access, tend to receive substantial increments of chemicals, which are then concentrated as the water is removed, used for irrigation, drinking water, or industrial processes, and returned to the stream. The combination of natural addition of chemicals, plus additions of chemical pollutants from human activitity (often large), causes the total quantity of a chemical to increase as the

Figure 7–4

Mercury Concentrations [a] on the Delaware River, Between Mile Points 55 and 127



[a] Average concentrations for period 1972 to 1979 based on from 115 to 129 measurements per station.

Source: CEQ UPGRADE System.

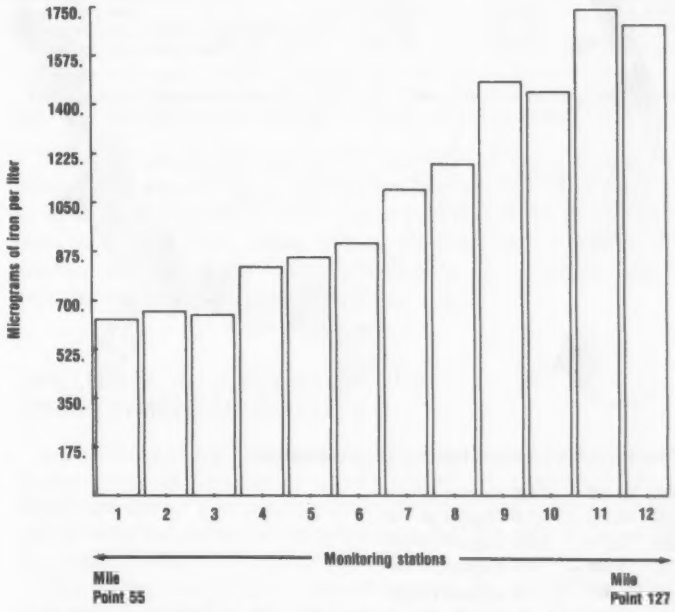
river approaches the sea. If the increase in the quantity of the chemical is balanced by an increase in dilution due to the greater flow in the downstream reaches of a watershed, then the concentration of the chemical throughout the watershed is about the same. This is the situation for mercury in the Delaware River (Figure 7–4), even though the quantity of mercury is much greater near the mouth of the river than upstream.

If, on the other hand, a chemical is added to the watershed more rapidly than the flow increases, then not only does the total amount of the substance increase downstream, but the concentration also increases. In the Delaware River, iron shows this kind of increased concentration with increased flow (see Figure 7–5).

When the chemicals carried by the rivers reach the coastal estuaries, up to 90 percent may be stored in the sediments as a result of complex physical and chemical processes.[3] Consequently, shellfish are not only exposed immediately to the chemicals; but because of their accumulation in the sediments, the chemicals can also be the

Figure 7–5

Iron Concentrations[a] on the Delaware River, Between Mile Points 55 and 127



[a] Average concentrations for period 1972 to 1979, based on from 275 to 292 measurements per station.

Source: CEQ UPGRADE System.

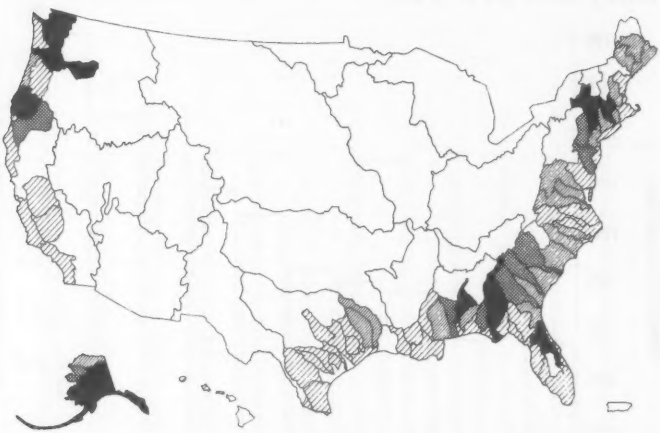
source of future problems. If, for example, a channel is dredged, the material may be stirred up and released. EPA's 1972 Water Quality Criteria documents, citing several references, state: "Evidence tends to support the contention that nutrient fertilization and possible release of toxic materials can occur with resuspension of bottom material[s] . . . [which] may occur during dredging . . . ." [4]

Heavy metals—such as mercury, lead, and cadmium—are among the pollutants that are caught and held in estuaries. Some of these metals are harmful in extremely small, highly diluted quantities. For example, the criterion level for mercury for marine life (that is, the level above which harmful effects may be expected) is 0.10 micrograms per liter, or one part of mercury per hundred million parts of water.[5]

Figure 7–6 depicts levels of cadmium in watersheds draining into the marine environment in the United States. It shows that the nationwide pattern of heavy metals entering the marine environment is

Figure 7–6

Quantities of Cadmium Draining from Coastal Watersheds into the Marine Environment



Total Dissolved Cadmium Draining From Watershed

- 292,000 — 66,540 Kilograms per year
- 36,840 — 13,140 Kilograms per year
- 11,970 — 5,209 Kilograms per year
- 5,090 — 969 Kilograms per year
- 903 — 0 Kilograms per year
- not analyzed

Source: CEQ UPGRADE System.

quite complex, with different watersheds displaying different patterns.

In most cases, the concentrations of these metals dissolved in the streams are not at toxic levels, and do not constitute a hazard to humans or the biota unless they are slowly concentrated through the food chain. But when the concentrations in the flowing water are translated into total quantities of material transported, and if one considers that most of this material is deposited in estuaries, the picture that emerges is one of potentially serious cumulative impact on the estuaries. Table 7–3 indicates how much of the trace metals of an estuary are found right at the water's surface.

Table 7–3

Trace Metal Concentrations at the Mouth of the Canary Creek Salt Marsh in Delaware, Averaged Over the Spring, Summer, and Fall of 1975

(parts per billion)

Averages for the Tidal Cycle	Copper	Zinc	Iron
Water, flood	1.2±0.07	1.3±0.07	14.3±0.8
Water, ebb	1.3±0.08	1.6±0.08	39.0±2.0
Microlayer, flood	14,800	103,400	13.9×10^6
Microlayer, ebb	13,800	90,400	15.4×10^6
Particulate, flood (39.4 mg/liter)	37,200	169,000	20.1×10^6
Particulate, ebb (65.4 mg/liter)	26,000	139,000	18.4×10^6

Source: R. E. Pellenbarg, and T. M. Church, "The Estuarine Surface Microlayer and Trace Metal Cycling in a Salt Marsh," *Science* 203:1010 (March 1979).

Table 7–4 shows estimates of the quantities of heavy metals discharged into estuarine ecosystems by the four largest U.S. rivers. Not all of this material comes from human activities; some of it derives from substances in the native rock of the watershed. However, the addition of metals from human activities may raise the amount in estuarine ecosystems to potentially harmful levels.

MOLLUSCS AS INDICATORS OF ENVIRONMENTAL QUALITY

A well-functioning ecosystem signifies that human and other activities have not stressed the system beyond the system's ability to absorb the stress.[6] This not only indicates the compatibility of human actions with the system, but also indicates that the system is available for prudent commercial and recreational use.

One of the most effective ways of assessing the health of a coastal ecosystem is to look at the condition of its molluscs. These shellfish live in the mud or sand bottoms of aquatic ecosystems and accurately reflect some important aspects of environmental quality. They are

Table 7–4

Contribution of Dissolved Metals to Coastal Waters by the Four Largest U.S. Rivers

	Yukon	Columbia	Mississippi	St. Lawrence
Mean Discharge, (cubic ft/sec)	326,200	207,000	487,500	261,800
Discharges into	Bering Sea	Pacific	Gulf of Mexico	Atlantic
Time period	6/75–9/77	2/74–7/77	1/74–7/77	4/74–8/77
Approximate number of quarterly samples	9	12	12	10
Contribution (metric tons per year)				
Arsenic	452	234	not measured	170
Cadmium	292	110	none detected	64
Chromium	none detected	none detected	306	749
Cobalt	66	29	112	56
Copper	1,569	1,246	1,730	379
Iron	126,000	8,040	3,177	4,727
Lead	1,150	528	280	316
Manganese	10,140	198	4,370	1,298
Mercury	36	1	11	90
Selenium	41	88	1,313	106
Zinc	2,131	2,953	6,453	8,409

Source: J. D. Buffington, L. J. Milask, C. Graves, and S. Fullerton, "Use of River Basin Water Quality Monitoring Data to Analyze Heavy Metal Input to the Marine Environment," *Proceedings of the World Meteorological Organization International Symposium on Multi-Media Global Monitoring of Environmental Pollution*, Riga, U.S.S.R., 1978 (in press).

useful monitors of estuarine ecosystems and land-water interactions for several reasons:

- Sensitivity to human-induced changes in the environment. When subjected to pollution, the organisms themselves may show direct adverse effects, or they may accumulate chemical substances or bacteriological levels that are not always harmful to them, but render them unfit for human consumption;
- Existence of systematic monitoring. Because of this public health aspect, quantitative records are available showing total shellfish acreages, including those safe for harvesting and those closed due to possible public health impacts;
- Their stationary nature (except for the early egg and larval stages). Molluscs filter large quantities of estuarine water and thus continually sample the environment for extended times, reflecting environmental changes in the waters in which they dwell;
- Their longevity, many species, and cosmopolitan distribution; and
- Their commercial importance. This means there are reliable quantitative data on harvest and other aspects of resource uses.

Molluscs can be used as indicators of environmental quality both by measuring the amount of pollutants accumulated in shellfish tissue and by keeping track of population changes through harvest statistics. Accumulation of contaminants in these organisms, or disease, death, reduction of local abundance, or even extinction of entire

populations, indicate varying degrees of deterioration of a coastal ecosystem.

MEASURED POLLUTION LEVELS IN MOLLUSCS

There have been two major studies of trends in bioaccumulated pollutants in shellfish—one, an EPA-sponsored study of organochlorine pesticides in the shellfish of 15 states from 1965 to 1972,[7] the other an EPA program known as Mussel Watch, initiated in 1976 and still in operation.[8]

In nature, DDT degrades to DDD and DDE, which are similar in their environmental effects to DDT. Table 7–5, which is based on information provided by the two studies mentioned above, indicates that these animals still contained DDT residues 4 years after the use of the chemical was banned in 1972. Because the most recent data differ from the earlier data in sites sampled, they are not strictly comparable. Too detailed an interpretation, beyond the fact that the DDT problem remains with us, is probably not warranted. However, the fact that we still have a DDT problem is not surprising because the chemical and its relatives, DDD and DDE, are extremely persistent. Evidence of the positive effect of the DDT ban can be found in a variety of organisms. For example, the map showing changes in DDT residues in freshwater carp flesh (Figure 7–7) points to definite improvement during the past 8 years.

Figure 7–7

Areas of Improvement and Deterioration in Levels of DDT in Freshwater Carp Tissues

Change in mean levels for 1969–73 versus 1974–77
Over 25 percent improvement
10 to 25 percent improvement
Under 10 percent change
10 to 25 percent worsening
Over 25 percent worsening

Source: U.S. Environmental Protection Agency STORET system.

Table 7–5

Percent Distribution[a] of DDT Metabolites (DDE and DDD) in Mussel Tissue by State, 1965–76

State	Concentration Class (parts per billion)	1965	1966	1967	1968	1969	1970	1971	1972	1976
California	0–10.9	—	47	34	13	19	10	39	59	21
	11–100	—	48	42	52	47	55	53	41	71
	101–1000	—	4	24	35	34	34	7	0	4
	Greater than 1000	—	0	0	0	[b]	0	0	0	4
Florida	0–10.9	83	57	47	42	59	100	100	100	100
	11–100	17	43	44	48	34	0	0	0	0
	101–1000	0	0	8	8	5	0	0	0	0
	Greater than 1000	0	0	[b]	2	2	0	0	0	0
Georgia	0–10.9	—	—	78	79	86	83	88	80	100
	11–100	—	—	22	21	14	16	12	19	0
	101–1000	—	—	0	0	0	0	0	0	0
	Greater than 1000	—	—	0	0	0	0	0	0	0
Maine	0–10.9	100	91	98	91	94	99	—	—	67
	11–100	0	9	2	9	5	2	—	—	33
	101–1000	0	0	0	0	0	0	—	—	0
	Greater than 1000	0	0	0	0	0	0	—	—	0
New York	0–10.9	—	61	34	60	53	34	48	49	0
	11–100	—	37	66	38	46	66	52	50	100
	101–1000	—	2	1	1	[b]	1	0	[b]	0
	Greater than 1000	—	0	0	0	0	0	0	0	0

North Carolina	0–10.9	—	22	27	44	48	67	83	78	100
	11–100	—	78	72	55	52	33	16	21	0
	101–1000	—	0	[b]	1	[b]	0	1	2	0
	Greater than 1000	—	0	0	0	0	0	0	0	0
South Carolina	0–10.9	87	75	70	81	92	—	—	—	0
	11–100	13	25	30	19	8	—	—	—	100
	101–1000	0	0	0	0	0	—	—	—	0
	Greater than 1000	0	0	0	0	0	—	—	—	0
Texas	0–10.9	72	44	43	47	52	56	70	46	—
	11–100	26	49	52	46	43	40	28	54	—
	101–1000	2	7	5	7	5	4	2	0	—
	Greater than 1000	0	0	0	0	0	0	0	0	—
Virginia	0–10.9	29	42	42	45	49	52	48	39	0
	11–100	71	56	58	53	51	48	52	61	100
	101–1000	0	2	0	1	0	0	0	0	0
	Greater than 1000	0	0	0	0	0	0	0	0	0
Washington	0–10.9	98	96	98	100	—	—	—	—	92
	11–100	2	4	2	0	—	—	—	—	8
	101–1000	0	0	0	0	—	—	—	—	0
	Greater than 1000	0	0	0	0	—	—	—	—	0

[a] Percentage found by dividing the number of samples showing a concentration by the total number of samples for that state and year. For each year the numbers for a state will add up to 100 percent (except for rounding errors). Therefore, an increase in the 0 to 10.9 parts per billion class over time is indicative of an improvement in water quality.

[b] Less than one-half percent of the samples contained concentrations in this class.

Sources: P.A. Butler, "Organochlorine Residues in Estuarine Mollusks, 1965–1972—National Pesticide Monitoring Program," *Pesticides Monitoring Journal* 6(4): 238–362 (1973); E.D. Goldberg, V.T. Bowen, J.W. Farrington, G. Harvey, J.H. Martin, P.L. Parker, R.W. Risebrough, W. Robertson, E. Schneider, and E. Gamble, "The Mussel Watch," *Environmental Conservation* 5(2): 101–125 (1978); U.S. Environmental Protection Agency STORET System.

The Mussel Watch program, which gathers data nationwide, is too recent to have yielded enough data for detection of trends. Three years of data have been gathered, but only the first year's are available at this time. Nonetheless, differences in pollutant concentrations in different regions of the country are already evident.

The Mussel Watch program has detected one hot spot of high DDT residues—that is, concentrations above 100 parts per billion (ppb)—in southern California. This has been interpreted as the result of contaminated wastewater discharges in the past.[9] The situation for polychlorinated biphenyls (PCBs), the manufacture and some uses of which have now been banned (see Chapter 3), is more alarming. Table 7–6 shows the distribution of PCB concentrations in molluscs nationwide. Even molluscs in otherwise relatively clean waters show as much as 50 ppb. Far higher values—even above 600 ppb—have been observed in molluscs from locations such as Boston Harbor, Narragansett Bay, R.I., and Rockaway on the south shore of Long Island, N.Y. PCBs, like DDT and its breakdown products, are long-lived. These high recorded concentrations of PCBs indicate that the residues will be contaminating the environment for a long time. Table 7–7 summarizes heavy-metal concentrations in molluscs in 1976 by EPA region. No geographic zones having exceptional concentrations of all metals have been observed. Individual metals do appear in unusual concentrations at certain locations, however—in some instances, at levels 100 times higher in one place than another.[10] The fact that Mussel Watch data have successfully detected major local and regional differences in heavy-metal pollution suggests that this is a sensitive method of detecting pollutants, as well as that serious pollution problems exist.

Exceptional geographic concentrations of individual metals should receive further study to determine the source of the high concentrations. For example, the mussels from south San Francisco Bay appear to have high silver concentrations. High cadmium, zinc, copper, and nickel concentrations have been detected in the Savannah River and Charleston, and in New York City, and New Haven, Conn.[11] It is not known for certain whether the origin of these high concentrations in particular locations is human or natural. A high concentration of copper, silver, and zinc found in Lake Sabine molluscs on the Gulf Coast, however, is suggestive of human influence, because concentrations observed there are so unusually high.

Mussels have also shown the presence of radionuclides, for the most part apparently a legacy of the weapons testing program of the 1950s and early 1960s. However, one sample from Plymouth, Mass., suggests that the mussels are concentrating effluents from a nearby nuclear reactor. The sample was two to three times higher in plutonium than the other high-plutonium samples, but low in americium.[12] This combination of high plutonium and low americium is characteristic of nuclear power plant effluent, but not of weapons-testing residue.

Molluscs in 4 of 83 Pacific and Gulf coast waters sampled show some petroleum pollution.[13] It is likely that if it were possible to better detect and identify oil residues, a larger number of stations would have shown oil pollution.

Table 7–6

Polychlorinated Biphenyls in East Coast and Bodega Head Mussels and Oysters

(in averages of parts per billion of the dry weight)

Location	Bivalve Type	PCB 1254
Bodega Head, Calif.	Mussel	▪ 51.8
Bodega Head, Calif.	Mussel	25.8
Bodega Head, Calif.	Mussel	▪ 61.8
Bodega Head, Calif.	Mussel	18.0
Bodega Head, Calif.	Mussel	20.8
Bodega Head, Calif.	Mussel	16.6
Bodega Head, Calif.	Mussel	29.6
Bodega Head, Calif.	Mussel	14.8
Blue Hill Falls, Maine	Mussel	14.9
Sears Island, Maine	Mussel	79.2
Cape Newagen, Maine	Mussel	54.8
Bailey Island, Maine	Mussel	59.4
Portland, Maine	Mussel	94.6
Cape Ann, Mass.	Mussel	96.3
Boston, Mass.	Mussel	635
Plymouth, Mass.	Mussel	226
Cape Cod Canal, Mass.	Mussel	215
Narragansett, R.I.	Mussel	626
Narragansett, R.I.	Mussel	496
Narragansett, R.I.	Mussel	281
Narragansett, R.I.	Mussel	475
Narragansett, R.I.	Mussel	300
Narragansett, R.I.	Mussel	371
Sakonnet Point, R.I.	Mussel	120
Block Island, R.I.	Mussel	102
Millstone, Conn.	Mussel	321
New Haven, Conn.	Mussel	129
Manhasset Neck, N.Y.	Mussel	838
Herod Point, N.Y.	Mussel	316
Great Gull Island, N.Y.	Mussel	272
Fire Island, N.Y.	Mussel	243
Rockaway, N.Y.	Mussel	575
Cape Charles, Va.	Oyster	31.5
Wachapreague, Va.	Mussel	136
Wachapreague, Va.	Oyster	84.4
Hatteras Island, N.C.	Oyster	15.0
Beaufort, N.C.	Oyster	37.8
Sapelo Island, Ga.	Oyster	17.2
Savannah River, Ga.	Oyster	33.1
Charleston, S.C.	Oyster	81.9
St. Augustine, Fla.	Oyster	149
Pensacola, Fla.	Oyster	107
Biloxi, Miss.	Oyster	336

▪ Poor reproducibility.

Source: E. D. Goldberg, V. T. Bowen, J. W. Farrington, G. Harvey, J. H. Martin, P. L. Parker, R. W. Risebrough, W. Robertson, E. Schneider, and E. Gamble, "The Mussel Watch," *Environmental Conservation* 5(2): 114 (1978).

Table 7–7

Mean Heavy Metal Concentrations in Mollusc Tissues, 1976

(parts per million of the dry weight)

	EPA Region	Lead	Cadmium	Silver	Zinc	Copper	Nickel
I	(Northeast) [a]	4.02	1.82	0.01	101.62	6.20	1.12
II	(New York/New Jersey) [a]	2.79	2.69	0.16	119.57	7.53	2.07
III	(Mid-Atlantic) [a,c]	0.57	1.57	0.83	1326.43	39.06	1.96
IV	(Southeast) [a,d]	0.36	3.98	2.18	1957.06	120.76	2.15
VI	(Louisiana/Texas) [a]	2.35	5.09	1.89	1741.18	134.24	2.64
IX	(California) [a,b]	4.37	5.23	0.71	141.11	6.81	1.95
X	(Oregon/Washington) [a,b]	2.40	4.75	0.31	118.18	6.26	2.51

[a] *Mytilus edulis*, blue mussel.
[b] *Mytilus californianus*, Californian mussel.
[c] *Crassostrea virginica*, American oyster.
[d] *Ostrea equistris*, Japanese oyster.

Source: U.S. Environmental Protection Agency Mussel Watch Program.

The results of Mussel Watch lead to several conclusions. First, available data show that serious contamination of resident shellfish populations is taking place in many parts of the country. Second, as expected, mussels are good samplers and consequently good indicators of environmental quality. Third, the results show that certain toxic pollutants, particularly those that do not break down easily into nontoxic forms, are present in coastal waters and probably will be for many years to come. The molluscs have also pointed to problems whose cause is unknown, for example, high—and unexplained—levels of the radioactive element curium at Cape Charles, Va.[14] As more data become available, and as other nations start similar programs, a more detailed picture of the environmental quality of the estuarine waters in which mussels dwell will emerge.

SHELLFISH HARVESTS

A much less precise, but more long-term measure of the health of coastal ecosystems and the degree to which they have been stressed, is simply the numbers of molluscs present in these waters over the years. Records of commercial catches of clams and oysters offer a great deal of suggestive data on molluscs' ability to survive and propagate, an ability that is closely tied to environmental quality. The records indicate that the number of molluscs in coastal waters has been steadily declining during the years. Although damage to the environment is not the only cause—overfishing appears to have played a substantial role—the decline does suggest that significant alteration and degradation of the coastal ecosystem have taken place.

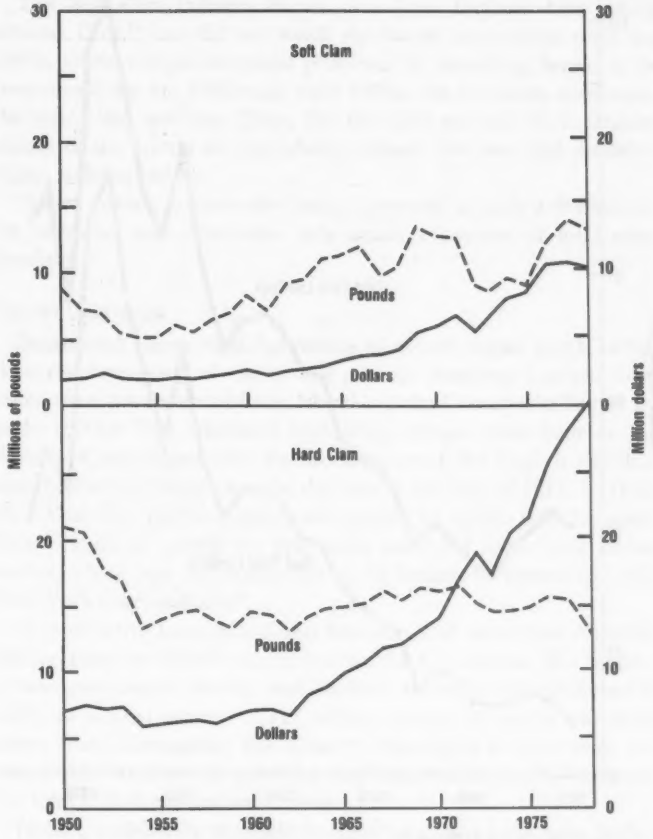
Clam Harvests

Large scale use of clams for human food began in the United States in the early 1900s, when canneries were established.[15] Four types of Atlantic Coast clams—hard, soft, surf, and ocean quahog—have made up 99 percent of the harvest, with the remaining 1 per-

Figure 7–8

U.S. Soft-Shell and Hard-Shell Clam Meat Landings, 1950–78[a]

(in pounds and value)



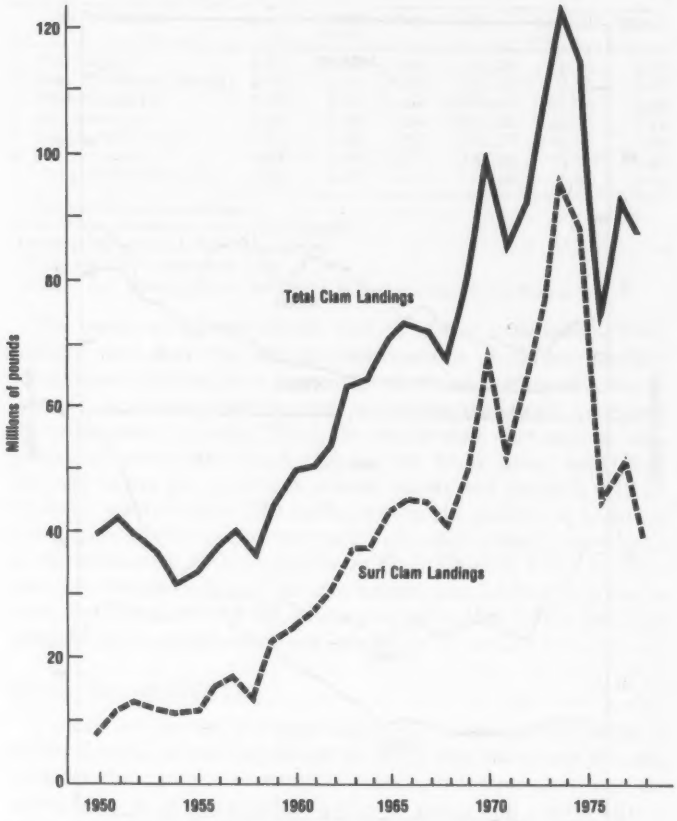
[a] 1976–78 values are preliminary.

Sources: U.S. Department of Commerce, National Marine Fisheries Service "A Comprehensive Review of the Commercial Clam Industries in the United States" (Washington, D.C., March 1977), pg. 49; U.S. Department of Commerce, National Marine Fisheries Service, "Fisheries of the United States, 1978", Current Fishery Statistics No. 7800 (Washington, D.C., April 1979), pg. 2.

cent coming from several Pacific Coast species.[16] Hard and soft clams dominated the total catch until the surf clam fishery burgeoned in the early 1950s. Since that time, combined harvests of soft and hard clams have stayed relatively stable, while total clam production tripled between 1950 and 1975 due to a spectacular increase in the surf clam fishery (Figures 7–8 and 7–9). Recorded

Figure 7–9

Total U.S. Commercial Clam and Surf Clam Meat Landings, 1950–78 [a]



[a] 1976–78 values are preliminary.

Sources: U.S. Department of Commerce, National Marine Fisheries Service, "A Comprehensive Review of the Commercial Clam Industries in the United States" (Washington, D.C., March 1977), pg. 46; U.S. Department of Commerce, National Marine Fisheries Service, "Fisheries of the United States, 1978," Current Fishery Statistics No. 7800 (Washington, D.C., April 1979), pg. 2.

landings in 1975 and estimated landings in 1976, 1977, and 1978 show a decline from these peaks.[17]

Although commercial catch records earlier than the past several decades are not entirely complete or reliable, they do indicate that hard clams were harvested in considerable volume during the depression of the 1930s and then increased to the near record landings in 1950.[18] Substantial commercialization of soft clams began about

1850, with maximum landings occurring from 1937 to 1940.[19] A decline in the 1940s in the New England fishery industry was compensated for by increased production from subtidal Maryland beds in the 1950s and 1960s. Signs of overfishing in the Maryland resource began to be observed in the early 1970s.[20]

The surf clam industry began as a New England bait fishery around 1870,[21] but did not reach significant proportions until the 1940s, when various technical problems in harvesting began to be overcome.[22] By the 1960s and early 1970s, the surf clam dominated the total clam landings. Then, like the hard and soft clam fisheries before it, the effects of overfishing, natural disasters, and pollution began to be apparent.

Ocean quahog is currently being harvested at only a fraction of its potential, and constitutes only about 1 percent of total clam landings.[23]

Oyster Harvests

Substantial commercial harvesting of oysters began much earlier than the harvesting of clams and mussels. Booming harvests were taken from the waters of Long Island and the Chesapeake Bay in the early 1800s.[24] The wholesale harvesting of vast oyster beds on the Atlantic Coast began with the introduction of the English schooner and the first sail dredge around the time of the War of 1812. In 1859, New York City residents spent more money for oysters than for meat. Some 7 million bushels per year were harvested from Long Island waters, which was the equivalent of 10 bushels of oysters for each New York City residents.[25]

As productive Long Island and New England areas were depleted, fishing pressure shifted southward to the Chesapeake Bay region. When government records and landings statistics were initiated in 1879, an annual harvest of 117 million pounds of oysters was being taken from Chesapeake Bay alone.[26] This figure is more than five times what the bay now provides, and is more than double the present total U.S. consumption of oysters.

In fact, nationwide domestic landings of oysters have been declining for decades. For example, in 1929, 90 million pounds (meat weight) were landed, although in the 1970s, the average annual landings stood at 54 million pounds (Figure 7–10). The decline occurred despite the contribution of oyster aquaculture, which accounts for approximately 40 percent of the U.S. oyster harvest.[27] The term "aquaculture" includes a wide array of activities from the simple transfer of seed oysters to growing areas, to the most sophisticated closed systems.

Although earlier records are not complete or totally reliable, they indicate a peaking of production nationally around the turn of the

Figure 7–10

Total U.S. Commercial Oyster Meat Landings, 1880–1978

Note: Due to problems in availability of data for landings prior to 1950, the landings shown for those years in most cases represent only a portion of the total U.S. catch. However in each case, the data represent, at a minimum, at least the landings for the Mid-Atlantic and Chesapeake areas, the nation's two largest oyster-producing regions. Were figures on the total U.S. catch known for those years, the decline shown in the graph would be even more precipitous. In addition, data for 1978 are preliminary.

Sources: C. H. Lyles, "Historical Catch Statistics (Shellfish)," U.S. Department of the Interior, U.S. Fish and Wildlife Service, *Current Fishery Statistics* 5007 (Washington, D.C., July, 1969); data for 1968–1978 provided by National Oceanic and Atmospheric Administration, National Marine Fisheries Service; data for 1912, 1920, 1925, and 1926 from E. M. Wallace, and G. R. Lunz, "The Oyster . . . A Shellfish Delicacy." *Marine Resources of the Atlantic Coast, Leaflet Number 11* (Washington, D.C.: Atlantic States Marine Fisheries Commission, October 1968); CEQ UPGRADE System.

century, with a declining trend starting much earlier than for the clam group, and continuing, with fluctuations, until the present.

Although mussels are an important food source in many parts of the world, their contribution to the U.S. molluscan shellfish harvest is negligible.

CAUSES OF DECLINES IN HARVESTS

The unmistakable picture emerging from this brief historical account of molluscan shellfisheries is one of decline. The decline of the oyster population is dramatic and was well under way by the turn

of the century. The decline in clam landings took place later and was masked by the emergence of the surf clam resource, unlocked by advances in harvesting technology.

These declines cannot be attributed to a sole cause; rather a complex of interacting factors seems to have been at work. Overfishing, habitat loss and deterioration, pollution, economic developments, natural disasters, and political and sociological considerations are all important and interrelated. The complex interactions among these factors make analysis difficult, and tidy conclusions impossible. However, some logical inferences are possible that point to long-term changes in coastal ecosystems.

Overfishing

It is generally agreed that overfishing was a major factor in the historical decline of oyster production, shown in Figure 7–10.[28] Regulations to restrict the use of efficient harvesting gear, establishment of quotas, and leasing of oyster grounds to private parties in certain states were developed in an effort to protect and restore the resource.

As noted, increasing exploitation of Chesapeake Bay clam stocks (made possible by advances in harvesting technology), has masked depletion of New England and Long Island stocks, but by the 1970s all of these stocks showed signs of depletion. Yet overfishing appears to be just one factor in the overall decline in availability of oyster and clam resources.

Habitat Loss

An extremely important factor is human alteration of estuarine habitat. In many areas, man has simply obliterated the estuarine environment necessary to the reproduction of these shellfish by dredging, filling, and draining. The reasons for this range from building an airport or vacation resort to needing a place to dump garbage. In other cases, man's activities have caused subtler alterations in this environment, such as changes in currents, salinities, temperatures, and turbidity that significantly affect the molluscs' ability to reproduce. Such activities include channelization, beach stabilization, and reservoir construction work.

Table 7–8 gives some indication of the rate of loss from direct physical elimination of, or damage to, estuarine habitat by dredging, filling, and similar activities. The Department of the Interior's National Estuary Study of 1970 shows an annual loss of estuarine habitat from these activities that translates to 0.21 percent annually from 1950 to 1969.[29] A study for the U.S. House of Representatives, published in 1970, indicates an annual loss of 0.36 percent between 1947 and 1967.[30] These are not spectacular losses on an annual basis, but they are cumulative and largely irreversible.

Construction of jetty for flood control purposes at Ocean Beach, Calif. Dredging for various purposes has been an important cause of damage to and loss of estuarine habitat.

To estimate the loss of our original estuarine habitat due to man's activities prior to 1947, when national records on this subject began being kept, is extremely difficult. However, the extent of loss of estuarine habitat and the causes are well documented in certain regions. For example, almost 30 years ago it was reported that 90 percent of the original acreage of tidewater marshland in the northeast states had been ditched, thereby changing its characteristics.[31] These activities have probably affected the clam resource most directly because clams grow in intertidal areas that are very close to shore and are intermingled with the tidewater marshlands.[32]

Table 7–8

Acres of Estuarine Habitat Important to Fish and Wildlife Estimated as Lost From Dredging and Filling Operations, 1950–69

Estuarine Zone	Acres of Important Habitat (thousands)	Acres Lost Through Dredging and Filling (thousands)	Percent Lost 1950–1969
North Atlantic	271.0	2.5	0.9
Middle Atlantic	2,201.8	77.0	3.5
Chesapeake	603.3	5.0	0.8
South Atlantic	823.8	42.3	5.1
Biscayne and Florida Bay	922.2	21.1	2.3
Gulf	8,325.0	426.7	5.1
S.W. Pacific	388.0	46.2	11.9
N.W. Pacific	• 2,142.0	21.0	1.0
Totals	15,677.1	641.8	4.1

• Includes all of Puget Sound.

Source: Based on material contained in U.S. Department of the Interior, Fish and Wildlife Service, *National Estuary Study, Volume 2* (Washington, D.C.: U.S. Government Printing Office, January 1970), p. 122.

Changes in Salinity

The effect of direct physical change that alters, but does not eliminate, estuarine habitat is even harder to assess. Water resource developments, such as locks and dams, alter the natural regimen of high and low flows into the estuarine zone, to which the molluscan shellfish may have adapted. But changes in salinity are especially destructive. Urban or industrial development may use so much freshwater that in dry years none reaches the estuary. This has happened on the Texas coast, where freshwater inflows are a critical factor under natural conditions in maintaining the brackish water salinity needed by shellfish.[33]

The interactive effects of hydrological modifications can be quite complex. Some changes in currents and freshwater inflows may bring about improved water conditions or greater supplies of nutrients. In the brackish waters of the Mississippi River, for example, an increased freshwater inflow that reduces the effectiveness of the oyster seed beds also eliminates predators and pests on the oysters.[34]

Even the building of a sewage treatment plant has the potential to adversely affect shellfish habitat by altering salinity. Trouble arose for the shellfish of Great South Bay when attempts were made to solve Long Island's sewage disposal and water quality problems. Long Island depends on ground-water aquifers for more than 90 percent of its freshwater.[35] In the past, water filtering into the aquifer from cesspools or septic tanks added about 120 million gallons a day to the ground water—a significant increment.[36] But Long Island has suffered some problems from polluted ground water. Nassau and Suffolk Counties on Long Island proposed to solve the problem by converting to centralized sewage treatment.[37] It was expected that

the project would improve the quality of the ground water but at the expense of reducing its quantity. However, Great South Bay receives a large proportion of its freshwater supply from ground water. Planners recognized that salinity in the bay would likely increase, and thus could possibly alter the ecology of the estuary.[38] This estuary has great economic value. In 1974, half the harvest of hard clams in the United States came from Long Island waters and of this, 80 percent comes from Great South Bay.[39] The bivalve shellfish harvest for the first 7 years of this decade averaged $16 million per year, with Great South Bay accounting for half of this amount.[40]

Even without the proposed sewage project, other construction projects would have led to significant increases in salinity in Long Island's bay waters (see Figure 7–11). Moreover, pressure on the shellfish resource from other sources remains high. Shellfish digging permits issued by New York continue to increase (see Table 7–9). Many areas have been "uncertified" for shellfish harvesting because of pollution problems (see Table 7–10). Molluscs harvested did not decline from 1970 to 1973 (see Table 7–11). However, a doubling of the fishing effort was required to maintain this level.[41] Available shellfish had declined due to increased mortality of clam larvae and a reduced rate of spawning.

Salinity, according to a fishing industry spokesman in an affidavit presented before a federal court, may be the most important characteristic determining the bay's shellfish productivity.[42]

For the hard shell clams, the optimum salinities for spawning and survival of larvae appear to be in a narrow range between 18 and 27 parts per thousand (ppt), with best results in the range of 20 to 24 ppt.[43] The reproductive patterns and survival of shellfish predators, such as starfish, are determined by a combination of salinity and water temperature. In the warm waters of shallow bays like Great South Bay, developing starfish larvae will not survive when salinities are low, around 20 to 25 ppt. But if salinities are above 28 ppt, the starfish larvae can survive even in warm waters.[44] The present salinity value in

Table 7–9

New York State Shellfish Digging Permits,[a] Full and Part Time, 1970–76

Year	Number of Permits	Year	Number of Permits
1970	5,547	1974	8,027
1971	6,026	1975	9,216
1972	5,832	1976	9,792
1973	6,462		

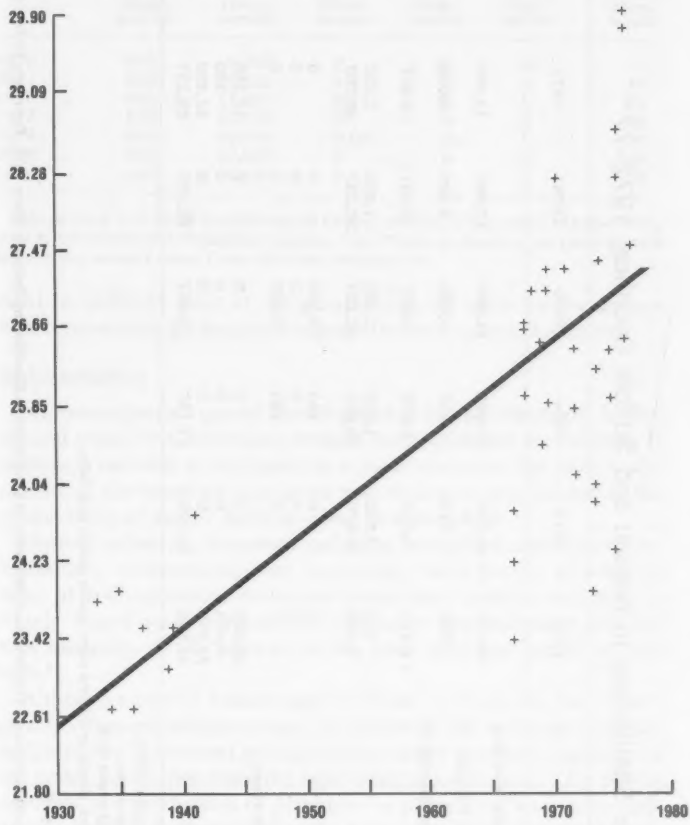
[a] Issued to residents only; figures do not include permits issued for lobstering and crabbing.

Source: U.S. Environmental Protection Agency, *The Effects of Sewering on Long Island's Shellfishing Industry* (New York, February 1978), p. 57.

Figure 7–11

Salinity of the Great South Bay, Long Island, 1930–77

(in parts per thousand)



Source: U.S. Environmental Protection Agency, "The Effects of Sewering on Long Island's Shellfishing Industry" (New York, February 1978), pp. 86–87; CEQ UPGRADE System.

most parts of the bay ranges from 22 to 26 ppt and is therefore at a maximum level for the health of the hard shell clam and the exclusion of various predators including starfish and oyster drills. "Thus, the Bay is in a precarious balance," says an industry spokesman. "Any significant increase in salinity could therefore be detrimental." [45]

In light of the possible damage to the Great South Bay fishery, and also because full information is lacking, EPA is sponsoring a study on possible adverse impacts and alternatives.[46] EPA has reserved the

Table 7–10

Acreage Uncertified for Shellfishing in Nassau and Suffolk Counties, 1972–77 [a]

Area	1972	1973	1974	1975	1976	1977	Total Marine Acreage
Hempstead Bay (Hempstead, Middle, and East Bays)	[b] 5,650	[c] 10,950	10,950	11,850	11,850	11,850	11,850
South Oyster Bay (Wantagh State Parkway to Amityville Channel)	700	[f] 1,015	1,015	4,020	4,020	[b] 4,020	6,190
Great South Bay Proper (Amityville Channel to Howell Point)	[c] 2,515	3,605	3,807	3,807	3,807	[c] 3,807	58,280
Bellport Bay	500	[d] 500	1,030	1,030	1,030	1,030	5,595
Subtotals	9,365	16,070	16,802	20,707	20,707	20,707	81,915
Atlantic Ocean to 3-Mile Limit							
Nassau County	0	0	340	3,140	0	0	28,700
Suffolk County	0	0	0	0	0	0	231,500
Subtotals	0	0	340	3,140	0	0	260,200
Long Island Sound to Adjacent State Lines							
Nassau County	20,950	0	0	0	0	37,150	—
Suffolk County	2,800	0	0	0	0	300	—
Subtotals	23,750	0	0	0	0	37,450	342,115
Annual Total	33,115	16,070	17,142	23,847	20,707	58,157	—

[a] As of Jan. 1 (year) unless otherwise noted.
[b] Offshore extension of uncertified areas.
[c] Offshore extension of uncertified areas GSB.
[d] Unspecified areas, although duck waste problems were acute about this time.
[e] Closure around Jones Inlet.
[f] Closure around Cedar Creek Outfall.

Source: U.S. Environmental Protection Agency, *The Effects of Sewering on Long Island's Shellfishing Industry* (New York, February 1978), p. 54.

Table 7–11

Bivalve Mollusc Harvest From The Great South Bay Complex, 1970–76

Year	Hard Clam		Soft Clam		Oyster	
	Bushels (thou-(sands	Dollars (thou-sands)	Bushels (thou-sands)	Dollars (thou-sands)	Bushels (thou-sands)	Dollars (thou-sands)
1970	578	5,393	3	15	0.1	1
1971	629	9,521	1	7	2	30
1972	625	11,691	0.2	2	1	21
1973	572	10,518	0	0	2	36
1974	617	12,351	0.02	0.4	1	24
1975	653	12,921	0	0	2	40
1976	700	16,873	0	0	2	39

Source: New York State Department of Environmental Conservation (1970–1976), in U.S. Environmental Protection Agency, *The Effects of Sewering on Long Island's Shellfishing Industry* (New York, February 1978), p. 31.

right to withhold some of the grant money set aside for the sewage treatment system if adequate mitigation measures are not adopted.

Sedimentation

Sedimentation is a special kind of physical habitat alteration. Under natural conditions, rivers and streams carry sediments to estuaries. If sediments increase substantially in a particular area, the natural dynamics of the estuarine ecosystem tend to create new habitat as the productivity of earlier habitat is lost or diminished.

Human activities, however, including intensified agriculture, urbanization, construction, and lumbering, have greatly accelerated rates of sedimentation. Sediment loads from construction sites in Rhode Island were reported in 1975 to be approximately 228,000 tons annually, or 25 percent of the total sediment runoff in that state.[47]

Although estuarine habitat may continue to exist in the face of such greatly increased sedimentation, its suitability for molluscan shellfish is diminished. Increased sedimentation causes increased turbidity of the water, which decreases the light penetration necessary for photosynthesis and production of plankton—a prime food source for molluscan shellfish. Sediments may also bury large areas of shellfish beds. For example, during a 36-year period, 6,000 to 7,000 acres of productive oyster reefs were smothered in Matagorda Bay, Tex.[48] Besides smothering adult shellfish, increased sediments cover the hard estuary floor that the larval stages of many species require as a surface on which to settle.

Pollution

There is general agreement that pollution has been a major cause of the decline of molluscan shellfish within recent decades.[49] It is the principal problem confronting the commercial hard clam fishery, and

a major one for the soft clam and oyster fisheries. Commercial surf clam harvesting, which occurs offshore in relatively deep water of near oceanic quality, has been relatively unaffected by water pollution. However, recent closures of substantial fishing areas in the New York Bight and off Maryland and Delaware clearly indicate that even this fishery is not immune to pollution.

Pollution includes contamination by heavy metals, chlorohydrocarbons, chlorine, and other effluents from industrial and power plants (including discharges of heated water). These substances can kill or damage the molluscan shellfish organisms outright or reduce their chances for survival. Oil spills and pesticides can have similar damaging direct effects. Treated and untreated human and animal wastes also pollute.

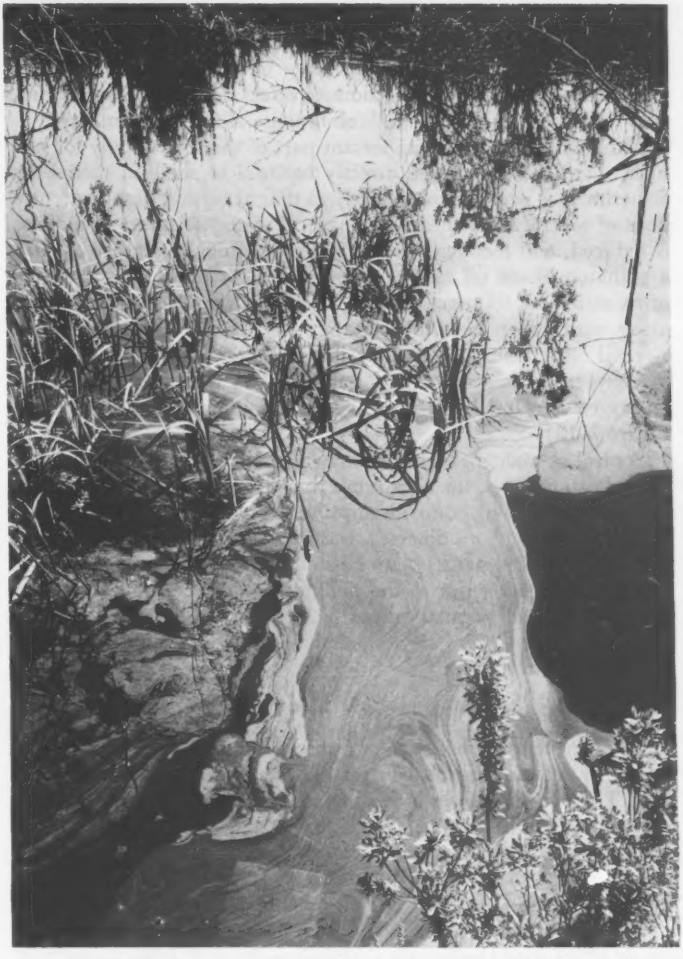
Molluscs can concentrate human pathogens such as those causing typhoid and hepatitis, or other microbial agents that do not affect the molluscs themselves but render them unsafe for human consumption. Noninfectious agents such as paralytic shellfish poisoning (PSP), Kepone, heavy metals, and other industrial and agricultural contaminants can also be concentrated by molluscs. Some of these pollutants, at some levels, may not adversely affect the shellfish themselves; some affect their marketability; and some make them dangerous for consumption.

A special case of pollution is that from surface runoff, or nonpoint sources. Runoff is a term applied to that part of the hydrologic cycle in which water flows diffusely over ground surfaces on its way to a collecting stream and on to the ocean, passing through the estuarine zone in the process. Under natural conditions, any adverse effects on shellfish from runoff will be at least partially compensated by beneficial impacts, such as generation of chemical nutrients. Under intensive human land and water use, however, runoff can become a major vehicle for transporting contaminants, excessive nutrients, and sediment to the estuary.

Pesticides, for example, are transported to the estuary, either in solution or adhering to particles, and then taken up by organisms or deposited in estuarine sediments. The uptake may occur either directly through ingestion and absorption or indirectly through the food chain.

Even in the Apalachicola Basin, described earlier as a largely natural ecosystem, runoff and nonpoint source pollution may present a problem. Here the uncontrolled and unregulated biological wastes of a 35,000-acre cattle ranch 10 miles upstream from the mouth of the Apalachicola River (see Figure 7–1) produces fecal loadings roughly equivalent to a city of 100,000 people.[50] This runoff could make the reduction of bay coliform counts by the new Apalachicola Treatment Plant much less effective.

Information concerning the concentrations and effects of specific types of bacteria and viruses in runoff is inadequate. This information is a pertinent aspect of the influence of runoff because total and



Polluted salt marsh in Middleton, R.I., in 1973. Pollution often accumulates in estuaries.

fecal coliform bacteria counts are used as an indicator of the possible presence of pathogenic microorganisms and form the basis of closing shellfish beds for public health reasons.[51]

Natural and human-induced changes in temperature, salinity, and nutrient levels in estuaries may result in algal blooms. Certain specific dinoflagellates in some algal blooms can cause concentration of a toxin in shellfish, and PSP in humans who eat them. The toxin can poison human beings even at levels that do not affect the shellfish themselves.[52]

One of this group of dinoflagellates *Gymnodinium breve,* is a rusty red and imparts a distinct color when appearing in great quantities, hence the term "red tide." Even when toxigenic organisms are not present in sufficient concentrations to affect human health, red tides may reduce the market for shellfish because of adverse publicity.

Although algae are an important part of the food supply for molluscs, algal blooms can be directly harmful to shellfish themselves. Experimental work has clearly shown that at certain high concentrations of several algal species, the rate of water transport to molluscs is reduced, and feeding ceases.[53] In June through October of 1976, a plankton bloom off of the New Jersey coast resulted in the death of an estimated 69 percent of the surf clam population in this area, along with other shellfish mortalities; in addition, migration and normal movements of finfish of this area were also affected.[54] The low oxygen levels responsible for the fish kills were probably a result of oxygen demand by microbes in decomposing the algal cells (see Figure 7–12).

Control of toxic algal blooms may or may not be possible through an understanding of the organism's role in estuarine and marine ecosystems. As a starting point, attempts to control nutrients from surface runoff as well as from domestic waste (sludge dumping, ocean outfalls, and septic systems) may have a beneficial effect. As long as the activities giving rise to the pollutants continue, and as long as there is a human population influx into coastal zones, the natural phenomena of red tides and other plankton blooms may occur with greater frequency and intensity.

Natural Forces

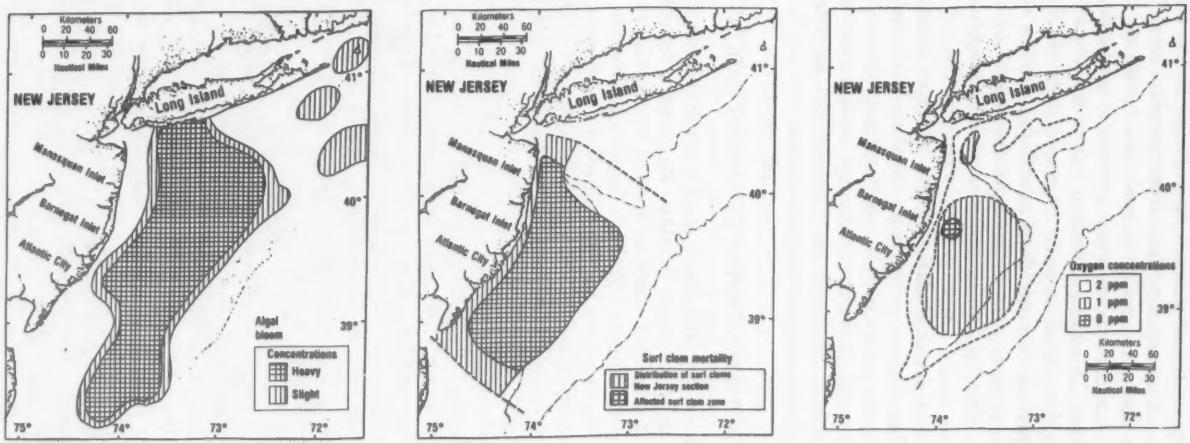
Although the emphasis of our discussion has been on damage caused by humans, natural forces can be destructive in their own right. The physical power of high winds and waves of hurricanes can cause alterations in beaches, sand bars, wetlands, and molluscan shellfish beds, ranging from minor alterations to total destruction. Shellfish beds may be broken up and scattered about or buried in sediment. The force of the hurricane may also open new passages or close old ones, altering current patterns and intensities. These changes can adversely affect sessile organisms that rely on flows of large amounts of water over their locations for feeding, distribution of larvae, and other natural functions.

Damage to shellfish resources from storms and flooding can be extensive, as in the case of Hurricane Agnes in 1972. But the damage is usually retrievable, and recovery is often rapid. Moreover, the adverse effects are sometimes partially compensated by beneficial ones.

Damage from natural causes, combined with ill effects of human activities, can be more severe and more lasting. Hurricane flooding can cause contamination of estuarine waters by raw sewage from treatment plants that are themselves flooded after heavy rains. The typical result is contaminated shellfish beds, which are then closed

Figure 7–12

Locations of Algal Bloom, Surf Clam Mortalities, and Low Oxygen Concentrations in the New York Bight, 1976



Source: F. W. Steimle, and C. J. Sindermann, "Review of Oxygen Depletion and Associated Mass Mortalities of Shellfish in the Middle Atlantic Bight in 1976," *Marine Fisheries Review* 40(12): 17–26 (December 1978), pp. 18, 21, 24.

to protect public health. Floodwaters in rivers and streams can transport large quantities of sediment and sludge, and at the same time flush pockets of poor-quality water from upstream areas. The riverine floodwaters and their pollution loads are ultimately delivered to estuaries, where the sediments can smother or contaminate the molluscan shellfish. In addition, flooding may adversely affect molluscs by exposing them to abnormally large quantities of fresh water for prolonged periods. Because flood runoff from urban watersheds is much more copious than from those dominated by natural ecosystems, the effect of human activities greatly compounds this kind of damage.

The potential for degradation also is increased where coastal development has removed protective coastal wetlands and vegetation. Development on barrier islands and dunes may have a similar effect. If there is a trend of increasing damage from natural catastrophes, the trend reflects increased development, not an increase in the occurrence of damaging natural phenomena.

OVERALL DETERIORATION OF ESTUARINE HABITAT

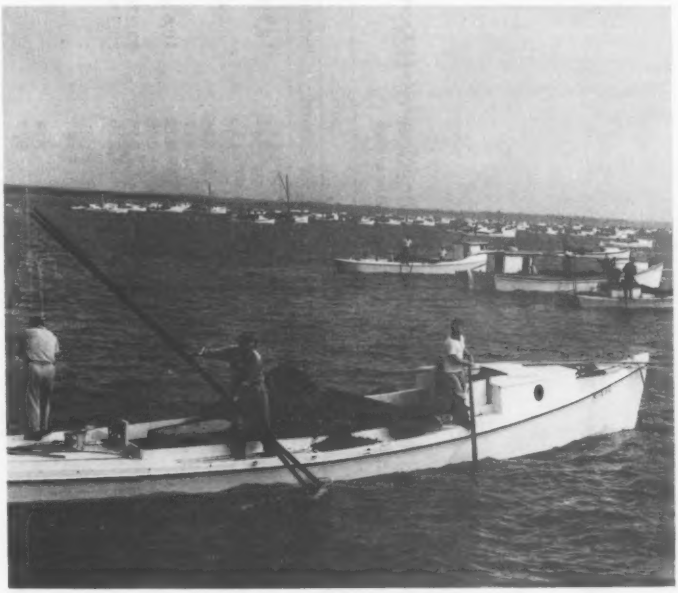
The National Shellfish Register of Classified Estuarine Waters is a compilation of estuarine habitats. Its purpose has been to track acreages that are either closed or open to commercial shellfishing by states under the National Shellfish Sanitation Program. Only three issues of the register have been published, the most recent in 1974 by EPA.[55] The first edition, in 1966, was compiled by the Public Health Service;[56] an intermediate issue was published in 1971 by the Food and Drug Administration.[57]

Beginning with 1971, the register included all estuarine waters of the coterminous United States. A total of 20.5 million acres were delineated, of which 14.6 million acres were classified as commercial shellfish waters and 5.9 million as noncommercial shellfish/nonproductive waters by the 1974 register.[58] Other compilations, defining the seaward boundary differently, have given different estimates of the estuaries of the United States. Table 7–12 shows the results of the most recent inventory.

The most recent National Shellfish Register, which shows 4 million of the 14.6 million acres of commercial shellfish waters to be closed, gives a quantified measure of habitat deterioration, as indicated by potential public health problems. Closure of shellfish beds is usually determined by coliform bacteria counts, which indicate unsanitary water quality. The register does not directly address the impacts of pollution on the shellfish, but the estimates it provides of habitat destruction point to this kind of impact. The coliform bacteria counts are used because they are associated with fecal wastes of warm-blooded animals and are therefore an indication of potential contamination from disease-causing organisms. Because universal standards and terminology for classifying waters and keeping records are lacking, it is difficult to discern absolute change in habitat.

Prohibited polluted areas (closed to shellfishing) have increased from 16.1 percent of all commercial and noncommercial shellfish waters in 1971 to 18.5 percent in 1974 (a 0.6 percent annual increase). This increase almost certainly shows that degradation is continuing and that detection and monitoring are increasing, although less rapidly than in 1966 to 1971, when areas closed to shellfishing increased by 1.3 percent per year.[59] As noted earlier, the rate of irreversible loss of physical habitat due to obliteration has been estimated as 0.21 to 0.36 percent annually;[60] these figures combined make a bleak picture. Moreover, there are other losses and deterioration that cannot be estimated because of lack of data. These losses include physical habitat alterations short of obliteration; reductions in the productivity of a resource still existing but under stress; and the adverse effects on the marketability of all shellfish—even those from unpolluted grounds—when pollution of these organisms is detected.

Despite its limitations, the register has been a very useful quantitative measure of the rate of deterioration. Currently, there are no firm plans by any federal agency for continuing to maintain the National Shellfish Register. If the register were revived, its weaknesses could be corrected, to make it more useful as a quantitative measure of change. Improvements might include adoption of universal standards for classification of waters and improved record keeping, as well as



Oyster fisherman on Chesapeake Bay.

Table 7–12

National Shellfish Register Classification of U.S. Waters, 1974

(in acres)

EPA Region	State	Waters				Nonproductive/Nonshellfish			Total Waters
		Open	Conditional	Restricted	Closed	Open	Closed	Other	
I	Maine	930,325	6,531	6,728	101,281				1,044,865
	New Hampshire					10,603			10,603
	Massachusetts	310,881	335	4,091	29,060	437,184	18,874		800,425
	Rhode Island	96,019	10,836		20,134				126,989
	Connecticut	248,751	2,227		68,956	71,265	1,961		393,160
	Total	1,585,976	19,929	10,819	219,431	519,052	20,835		2,376,042
II	New York	477,241	266		151,096	369,205	22,838		1,020,646
	New Jersey	244,695	7,544	23,370	119,581				395,190
	Total	721,936	7,810	23,370	270,677	369,205	22,838		1,415,836
III	Pennsylvania						5,796		5,796
	Delaware	205,153	153		28,251		40,540		274,097
	Maryland	1,213,576			111,319		[a] 2,732	[b] 203,641	1,531,268
	Virginia	1,315,209	724		120,271	821	66,838		1,503,863
	Total	2,733,938	877		259,841	821	115,906	203,641	3,315,024

IV	North Carolina	1,379,563			604,038		134,110		2,117,711
	South Carolina	199,323	1,344		74,917				275,584
	Georgia	49,494			154,473				203,967
	Florida	663,126	84,099		1,024,966	447,311	47,597		2,267,099
	Alabama	81,937	187,513		85,589	2,468	17,452		374,959
	Mississippi	76,232			27,678	1,469	267,030	17,845	390,254
	Total	2,449,675	272,956		1,971,661	451,248	466,189	[c] 17,845	5,629,574
VI	Louisiana	2,000,117			464,161	682,129	380,283		3,526,690
	Texas	822,447			285,168	518,986	4,136		1,630,737
	Total	2,822,564			749,329	1,201,115	384,419		5,157,427
IX&	California	11,178	4,718		263,045	34,132	59,592	[d] 153,068	525,733
X	Oregon	7,075	7,693		13,305	50,376	5,232		83,681
	Washington	155,655	21,313		42,382	1,809,267	7,502		2,036,119
	Total	173,908	33,724		318,732	1,893,775	72,326	153,068	2,645,533
	Grand Totals	10,487,997	335,296	34,189	3,789,671	4,435,216	1,082,513	374,554	20,539,436

[a] 2,732 acres conservation area, closed nonshellfish
[b] 203,641 acres unclassified, nonshellfish
[c] 17,845 acres conditional, nonshellfish
[d] 19,381 acres conditional, nonshellfish; 133,687 acres ocean

Source: U.S. Environmental Protection Agency, Office of Enforcement, *National Shellfish Register of Classified Estuarine Waters—1974*, EPA-330/1-75-002 (Denver, Colo., 1975), p. 17.

expansion to cover physical loss of shellfish beds from dredging, filling, and sedimentation.

Data from sources other than the register seem to confirm a national pattern of depletion of shellfish and their habitat. It appears that overfishing of many clam and oyster stocks has been responsible for initial declines, often reinforcing the effects of natural disasters and impeding recovery from them. Physical habitat elimination and degradation is roughly related to the pace of technological development and human population growth. Its influence has been felt more gradually, but in a cumulative and usually irreversible manner. Pollution, both industrial and domestic, but particularly the latter, has obviously contributed to declines in productivity, because almost 4 million acres of shellfish grounds have been closed since 1966 for public health reasons.

LEGISLATIVE BASIS FOR IMPROVEMENT

The coast is an immensely valuable resource, as a source of food, as a provider of recreational opportunities, as a storm buffer, and in many other ways. However, much of the value of this resource depends on the viability of the coast's complex ecology. As the fate of mollusc populations has shown, maintaining this ecosystem requires protection of habitat, prevention of pollution, and general sound management of the resource.

A number of laws provide legislative authority for maintaining the environmental quality necessary to a healthy coastal ecosystem. Chief among them is the Clean Water Act of 1972, as amended in 1977, which creates mechanisms for controlling industrial discharges, building and upgrading sewage treatment facilities, protecting wetlands, and controlling pollution from diffuse sources, such as agriculture and street runoff. A major challenge facing the nation today is control of pollution from these diffuse sources. Progress under this law is discussed in detail in Chapter 2.

Also of great importance is the Coastal Zone Management Act, which gives funds to states to develop programs for managing their coastal areas. Many states have improved their provisions for wetland, beach, and dune protection and have improved or instituted programs for managing offshore oil and gas extraction and other activities. However, not all states have such programs, nor are all equally stringent. A more detailed discussion of progress under this Act appears in Chapter 8.

Several other laws also provide mechanisms for protecting the coastal zone, especially its fisheries. The National Marine Fisheries Service (NMFS) compiled and categorized a list of such laws in its 1977 report cited earlier.[61] Table 7–13 presents this list, and includes the one relevant law passed since 1977—the Ocean Pollution Research Planning Act of 1978—as well. The laws are categorized ac-

Table 7–13

Legislation Affecting Shellfish Environmental Quality

Federal Water Pollution Control Act of 1972 and Clean Water Act of 1977 (1) (2) (3) (4)
Rivers and Harbors Act of 1899 (2)
Marine Protection, Research, and Sanctuaries Act of 1972 (1) (2) (4)
Fish and Wildlife Coordination Act of 1958 (3)
Estuarine Areas Act (4)
Commercial Fisheries Research and Development Act of 1964 (4)
Anadromous Fish Conservation Act (1) (4)
Fishery Conservation and Management Act of 1976 (4) (5)
Water Resources Research Act of 1964 (4)
The Submerged Lands Act (2) (3)
Deepwater Port Act of 1974 (2) (3)
The National Environmental Policy Act of 1969 (3)
Coastal Zone Management Act of 1972 and 1976 Amendments (1) (3)
Water Resources Planning Act (1) (3)
National Ocean Pollution Research and Development and Monitoring Planning Act of 1978 (4)

Note: Numbers in parentheses following each Act refer to the major problem(s) addressed by that act, as explained in the text.

Source: U.S. Department of Commerce, National Marine Fisheries Service, *Water Quality and Molluscan Shellfish: An Overview of the Problems and the Nature of Appropriate Federal Laws* (Washington, D.C.: U.S. Government Printing Office, March 1977), Appendix B; 33 U.S.C.A. §1701 (1978).

cording to the particular aspect of the overall problem they primarily address. The laws create one or more of the following:

(1) Grant programs to improve environmental and/or resource quality, e.g., for planning, constructing, and operating wastewater treatment facilities;
(2) Regulatory programs, e.g., EPA and U.S. Army Corps of Engineers permit programs;
(3) Coordinated planning and environmental overview programs, e.g., The Fish and Wildlife Coordination Act and National Environmental Policy Act;
(4) Research programs to determine water quality and habitat protection needs, status, trends, and remedial approaches; and
(5) Fisheries management programs containing provisions applicable to water quality and habitat protection.

The National Marine Fisheries shellfish report cited earlier concludes that these laws, if carefully implemented during a period of years, are adequate to protect the resource and should result in a healthy coastal environment.[62] However, as this report indicates, complete implementation of these laws has so far not taken place, resulting in the continued deterioration of the resource, albeit at a lessened pace.

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62. *Id.* pp. 95, 103.

CHAPTER 8

HUMAN SETTLEMENTS AND LAND USE

Many of today's basic land use patterns were well established by 1900. By then, the eastern forests had been logged and most of the prairies plowed. But, as any observer of the past 80 years can attest, these seemingly stable patterns, shown in Figure 8–1, obscure obvious and important changes that have taken place since 1900. Our new urban population depends on the vast consolidated farms of the Midwest and arid West for food, rather than on small farms adjacent to towns and cities. In the past, such farms provided visual relief and diverse wildlife habitat, as well as fresh produce. The changes in the nation's landscape since 1900 can be measured as well by the loss of topsoil, wetlands, and hardwood forests in rural America and by the scarcity of open space easily available for routine urban recreation.

In recent years these effects have increasingly been perceived as land use problems. An awareness has grown that positive steps must be taken to protect soils, safeguard critical systems and hazardous geological areas, preserve ecological and cultural diversity, and conserve the amenities of the nation's landscape. It has become increasingly clear that none of these resources can be taken for granted in the face of new and rapid rural growth; continued urban sprawl; demands for new energy, transportation, and industrial development; and other significant changes. The local, state, and federal governments have, therefore, established new laws and administrative practices that directly and indirectly affect land management practices everywhere.

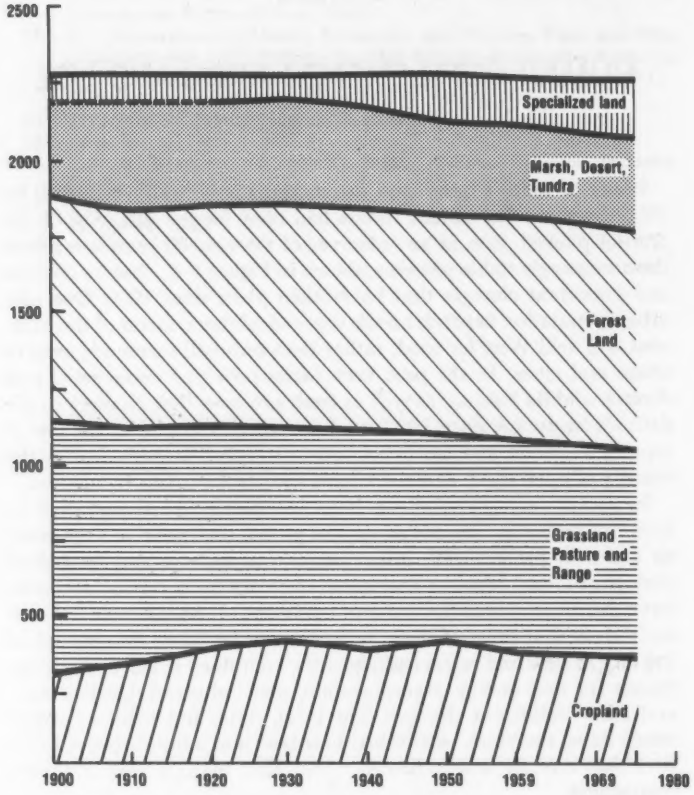
Government decisions on transportation, housing, agriculture, water resources, and the location of major facilities have direct and profound impacts on land use. Their importance is at least matched by the indirect implications that federal energy, defense, health and welfare, and tax policies have for land use. Federal programs to encourage local and state resource planning and management, such as the Coastal Zone Management Programs and those established by the Clean Water Act, also influence land use patterns by affecting state and local zoning and regulatory decisions throughout the country.[1]

Nonetheless, important as they are, all the local, state, and federal government activities combined have less influence on national land

Figure 8–1

Major Uses of Land in the United States, 1900–74

(millions of acres)



Note: *Forest Land* excludes reserved forest land in parks, wildlife refuges, and other special-use areas. *Specialized Land* is urban and built-up areas (including cities and towns, rural highway and road rights-of-way, railroads, airports, and public institutions in rural areas) and nonurban special-use areas (including Federal and State parks and other rural parks, recreational areas, Federal and State wildlife refuges, national defense sites, flood-control areas, Federal industrial areas, farmsteads, and farm roads).

Source: U.S. Department of Agriculture, Economics, Statistics, and Cooperatives Service, *Major Uses Of Land in the United States Summary for 1974*, draft, June, 1978, Table 3, p. 3a; U.S. Department of Argiculture, Economic Research Service, *Major Uses of Land and Water in the United States, Summary for 1959*, Agricultural Economic Report No. 13, pp. 10, 11; U.S. Department of Agriculture, Economics, Statistics, and Cooperatives Service, unpublished data.

use patterns than do the decisions of private business, large and small—decisions about where to build a factory or shopping center, or whether to invest in a new energy technology. The way the nation uses and manages its land is also profoundly affected by the decisions of millions of individuals and families: decisions about whether to establish a separate household, to move from one region to another, or to move from an urban to a rural area.

As discussed in this chapter, the collective social decisions about where and how to live have created numerous special land use problems. Rapid growth in rural areas throughout the nation, due to recreation, retirement, mining, improved transportation, and a variety of other causes, have created pressures that many local governments are ill-equipped to handle. Energy facilities along the coasts and new energy developments inland have highlighted the need for more effective coordination of decisionmaking and long-range planning at all levels of government.

However, efforts to protect and manage valuable national resources have shown encouraging results in the past year. Much progress has been made in effectively planning the use of one of the nation's most vulnerable areas—the coastal zone—as a result of the Coastal Zone Management Act.[2] In urban and rural communities, local, state, and federal policies are encouraging the preservation of valuable cultural and historical resources through measures supporting rehabilitation and continued use of existing structures and systems. In addition, the Administration announced important transportation policy changes to insure that, in the future, planning for new urban transportation projects will discourage urban sprawl and take into consideration the need for vital urban centers, energy conservation, and good environmental quality.

DEMOGRAPHIC CHANGES AFFECTING LAND USE

The United States continues to grow. Although birth rates have decreased from the highs of the 1945 to 1959 "baby boom," the U.S. population increased by almost 2 million people in 1978.[3] Illegal immigrants, not counted in the official census estimates, may add an additional several hundred thousand to population growth each year.[4] All increases in population place additional burdens on the land. The magnitude of these land use impacts depends on many factors including the rate of growth; the distribution of the new residents across the country; and population characteristics such as age, sex, race, mobility, education, employment, income, and household composition.

In the 1970s two demographic trends have become particularly striking in all parts of the country: the trend toward small households and population dispersal to rural areas. The Council on Environmental Quality (CEQ) case studies of five rural areas suggest that these growth trends are affecting land use patterns profoundly and are straining local services and critical lands.

INCREASE IN NUMBER OF SMALL HOUSEHOLDS

Since at least 1900 the average number of people occupying a housing unit has declined in the United States as families have become smaller, life expectancy has lengthened, and as older parents are less inclined to move in with their children. In the 1960s, when population grew at 1.3 percent per year, new households were formed at the rate of 1.8 percent per year. But since 1970, with population increasing at 0.8 percent per year, households are being formed at the rate of 2.6 percent per year.[5] Between 1970 and 1977, average household size dropped 10 percent, from 3.14 persons to 2.86 persons. The drop for this 7-year period was greater than that for the previous 20 years.[6]

The number of housing units has grown accordingly, as shown in Figure 8–2. Put in other terms, the U.S. housing supply had to increase by 10 percent from 1970 to 1977 just to accommodate the 1970 population.[7]

This recent trend stems from a variety of social causes: household formation by the 1946 to 1959 baby boom generation; high divorce rates; the enhanced ability of both young, single people, and the elderly to finance and maintain their own households; and delayed marriages are among the reasons often cited.[8] These social trends are accommodated, if not encouraged, by federal public housing

Figure 8–2

U.S. Housing Units, 1900–76

Source: U.S. Bureau of the Census, *Historical Statistics of the United States, Colonial Times to 1970* (Washington, D.C.: U.S. Government Printing Office, 1975), p. 646; U.S. Bureau of the Census, *Statistical Abstract: 1978* (Washington, D.C.: U.S. Government Printing Office, 1978), Table 2, p. 6, and Table 1377, p. 792.

construction programs sponsored by the U.S. Department of Housing and Urban Development (HUD), mortgage guarantees provided by HUD and the Veterans Administration (VA), and by federal tax provisions favoring home ownership and mortgage financing.

These household-formation trends have a substantial impact on land use trends. New-home construction continues despite high mortgage rates. In the country as a whole, single family homes still comprise the bulk of new housing starts, although more attached or multiunit housing units are being constructed.[9] Many of these homes are being built in previously rural areas, leading to further spreading of the suburbs and scattered development in agricultural regions. Even in some counties and towns with declining populations the trend has caused an increase in the number of occupied housing units.[10]

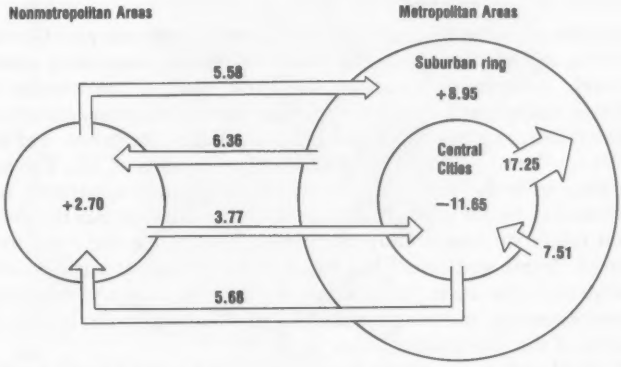
DISPERSAL TO RURAL AREAS

Americans' desire for independence and relative isolation, reflected in the housing unit trends, is also reflected in the nation's rural growth patterns. Between 1970 and 1977, when the U.S. population as a whole increased by 6.4 percent, nonmetropolitan population increased by 9.1 percent. By contrast, metropolitan population increased by only 5.4 percent. Approximately 2.7 million more people migrated to nonmetropolitan areas than left them. During the same period, 11.65 million more people left the central cities than moved to them [11] (see Figure 8–3).

Figure 8–3

Population Migration, 1970–78

(in millions)



Data refer only to individuals living in the United States in both 1970 and 1978, and thus do not include migration from outside the United States.

Source: U.S. Bureau of the Census, *CPR*, Series P-20, No. 285 (D.C.: U.S. Government Printing Office, 1975) p. 2; and U.S. Bureau of the Census, *CPR*, Series P-20, No. 331 (D.C.: U.S. Government Printing Office, 1978), Table 1, p. 5.

In the 1960s, 91 percent of the overall U.S. population increase occurred in metropolitan areas. Between 1970 and 1977 this figure had dropped to 62 percent. Nonmetropolitan counties are absorbing an increasing portion of the population growth, from 9 percent between 1960 and 1970 to 38 percent between 1970 and 1977, more than a fourfold jump.[12]

In fact, between 1970 and 1978, nearly 350 nonmetropolitan counties, containing about 8.5 million people, grew at a rate three times (16.7 percent) that of the nation—rates that are typically associated with developing nations, although there the growth is from high birth rates, not migration.[13] Growth rates for nonmetropolitan areas throughout the United States are illustrated in Figure 8–4.

In regional terms, as shown in Figure 8–5, the West—in particular Arizona, Nevada, and the mining areas of Wyoming—has the highest growth rate in the nation, followed by the South and the North Central regions. In the Northeast, by contrast, the overall population level has been stationary since 1970, as outmigration has offset the modest margin of births over deaths. Nevertheless, many rural areas in the Northeast are growing at a rate faster than rural areas in the South.[14] Some 500 nonmetropolitan counties are still declining in population, primarily in agricultural areas of the Corn Belt, the Great Plains, and the Mississippi Delta.[15]

The migration to rural areas represents a reversal of the previous decline in rural population, but not a return to a rural society. A continuation of the 1970 to 1975 rates to the end of the century would still result in a nonmetropolitan population proportionately less than that of 1950.[16] Nevertheless, the social, economic, and environmental implications of a continuation of this trend are significant.

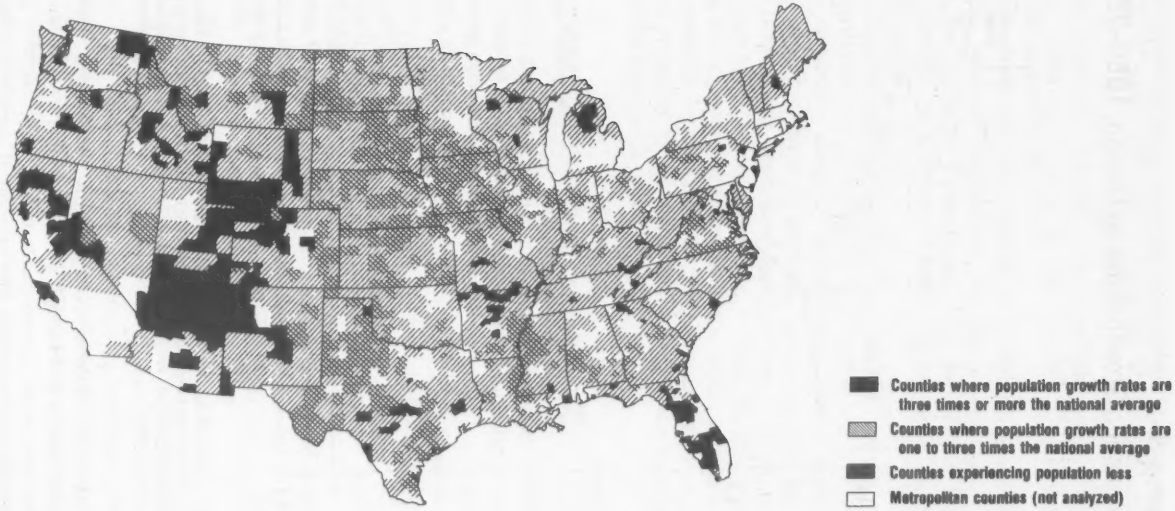
CAUSES OF MIGRATION TRENDS

Studies of current population shifts attribute current resettlement patterns to recreational development; retirement community development; government-sponsored stimulants such as construction of military, college, and state university facilities and highway and sewer construction; relocation of factories; new mining enterprises; and the desire for "rural amenities" and an improved quality of life. The importance of economic factors as growth stimulators apparently has decreased in recent years. No longer are job-related factors the dominant migration factor. Current research reveals that the attractiveness of "rural amenities" has become the dominant rural-growth stimulant.[17] The desire for access to recreational areas and resources, pleasant scenery, and relief from urban problems and pollution are all aspects of this phenomenon.

Federal and state policies have encouraged rural growth during the past decade by giving tax breaks to new industries and by other means, as a response to decline in rural population. Yet for many communities growth is now a "mixed blessing." Growth is economically desirable when it increases the number of jobs, expands the

Figure 8–4

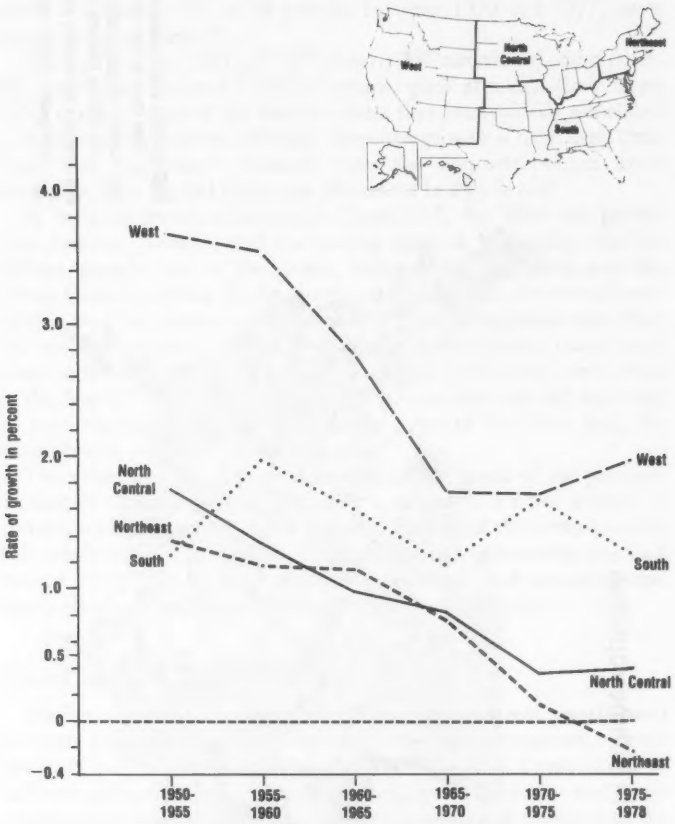
Rates of Population Change in Nonmetropolitan Counties, 1970–77


Counties where population growth rates are three times or more the national average
Counties where population growth rates are one to three times the national average
Counties experiencing population loss
Metropolitan counties (not analyzed)

Source: CEQ Upgrade System.

Figure 8–5

Population Growth Rates by Region, 1950–78



Source: U.S. Bureau of the Census, *Current Population Reports*, Series P–25: No. 304 (D.C.: U.S. Government Printing Office, 1965), Table 2, p. 10. No. 460 (D.C.: U.S. Government Printing Office, 1971), Table 1, p. 8. No. 727 (D.C.: U.S. Government Printing Office, 1978), Table 3, p. 7. No. 790 (D.C.: U.S. Government Printing Office, 1978), Table 1, p. 2.

tax base, and increases business and retail sales. However, rural growth today is not necessarily accompanied by economic expansion. Many newcomers are residents only during vacation periods. The recreation industry that they support is usually seasonal in nature with employees on a low pay scale.[18]

The economic, environmental, and social impacts of this new growth and development are of particular concern to many community planners in all parts of the country. For example, federal land

managers are concerned about the land use problems that communities on the edge of scenic public land can create. These communities have sprung up on the edges of federal park, forest, and recreation areas to cater to visitors. Adverse impacts include degradation of air and water resources, diversion of water supplies, alteration of wildlife habitats, and visual blight.[19]

Recreational growth and development are occurring in many areas that previously have not experienced this phenomenon. Parts of Maine, Ohio, the Ozarks, the Upper Great Lakes, the Colorado Rockies, and Appalachia—once depressed rural regions—are all experiencing growth booms.

The ability of communities to capture the potential economic benefits of this growth may depend largely on the extent to which they are developed economically already.[20] Development places increased demands on existing community services. Recent research by the Urban Land Institute has emphasized that rural communities are ill-equipped to cope with the needs, demands, and opportunities associated with this new growth—regardless of the particular growth stimulant. They generally lack appropriate planning, management, and environmental protection tools—such as zoning and subdivision regulations or building and health codes.[21]

IMPACT OF MIGRATION ON FIVE RURAL AREAS

To better understand the nature of rural settlement trends and their land use and related socioeconomic effects, CEQ is studying representative growing rural communities. The five are:

- The Catskills—Upper Delaware (Wayne and Pike Counties in Pennsylvania; and Sullivan, Delaware, Greene, and Ulster Counties in New York);
- Pamlico Sound (Beaufort, Carteret, Craven, Hyde, and Pamlico Counties in North Carolina);
- Rural Illinois-Wisconsin (Stephenson and Jo Davies Counties in Illinois, and Lafayette and Green Counties in Wisconsin);
- Southwestern Oregon (Jackson, Josephine, and Douglas Counties); and
- Taos-Santa Fe (Taos and Santa Fe Counties in New Mexico).

The areas were chosen to provide geographic diversity across the continental United States; a variety of land uses, e.g., resorts, agricultural districts; a variety of ecological systems, e.g., seashores, mountains, and deserts; differing degrees of development; differing distances from major urban areas; and different social and economic outlooks and characteristics.

Although the studies are still preliminary, several observations can be made. Although growth in all five areas brings economic and social benefits, it also is having two immediate adverse effects: failures in the provision of public services, and the loss of agricultural lands through conversion to homesites.[22]

"Sprawl" development in King County, Wash., is occurring on rural agricultural land. Once development occurs in a farm area, taxes on properties in the vicinity may escalate to the point where farming becomes prohibitive. Photographer: Doug Wilson

These and other adverse effects on both natural and human environments could be avoided through community planning. For the most part, however, regionally dependent communities such as those identified in the CEQ study, have no commonly held development goal or notion of future implications of development decisions. They frequently address problems—such as inadequate community services—individually and in the traditional *ad hoc* manner.

The long-term national results of this approach are still unclear but probably will be undesirable. Communities may make increasingly costly demands for energy, transportation, and public services in order to serve widely scattered settlements. Wildlife habitat and agricultural land may disappear. Development that might be made visually appealing, or at least unobtrusive, may, without planning and regulation, quickly dominate what tourists find to be attractive rural landscapes. Finally, the increasing settlement of city folks in rural areas, while bringing economic and social benefits, may also cause the gradual loss of traditional and unique rural cultures that lend strength and diversity to American society.

LAWS AFFECTING USE OF PRIVATE LANDS

A large number of federal laws affect private land use decisions directly or indirectly. These are summarized in Table 8–1. The large majority of these laws have objectives other than the promotion of wise land use *per se*. Nevertheless, in recent years significant federal attention has been given to the protection of critical resources—ecological, cultural, unique, and fragile—that contribute substantially to the quality of the environment and that need careful public management. None of these critical resources are categorically protected at the federal level. However, many recent federal laws and Executive orders serve to discourage incompatible uses of wetlands; lands overlying drinking water reserves; prime farmlands; floodplains; habitats of endangered species; and coastal, shoreline, wild, historic, and scientifically valuable areas.

This trend is even more evident among the states, which are the principal locus of the country's land management control. The legal efforts that states have made to protect critical resources are summarized in Table 8–2.

SPECIAL LAND USE PROBLEMS AND RESPONSES

Three of the more urgent land use problems facing the nation today are those of siting new energy facilities, protecting valuable coastal zone resources, and preserving fast-disappearing historic and cultural resources. Government programs exist that address these problems, although recent experience suggests that these programs could be strengthened, and that better coordination among the various levels and branches of government is needed.

SITING NEW ENERGY FACILITIES

Efforts during the past year to site three new energy facilities in coastal areas reveal many of the inadequacies of the current planning process for such plants, as well as the difficulty of evaluating numerous and varying environmental effects. These cases, discussed below, point up a particular need for improved efforts to identify environmentally critical areas so that their special-use limitations may be taken into account in the earliest stages of energy facility planning.

Better planning for the growth impact of energy facilities is also needed. This is demonstrated by the impact of existing coal and uranium operations in the Rocky Mountains and in Appalachia, discussed below.

Coastal Energy Facility Siting

The process of evaluating proposals for two major oil refineries on the East Coast—at Eastport, Maine, and Portsmouth, Va.—and for

Table 8–1

Federal Laws Affecting Private Land Use Practices

Name (citation)	Administering Agency	Primary Purpose	Land Use Effect
		Natural Resource Laws	
National Environmental Policy Act (42 USC §4321 *et seq.*)	Council on Environmental Quality	Reduce the degradation of the human environment and achieve a balance between development and resource use.	Requires federal agencies and licensees to analyze impacts of actions on land and water resources and to choose the environmentally preferable alternative or to explain why that alternative was not chosen.
Land and Water Conservation Fund (16 USC §4601–5)	Heritage Conservation and Recreation Service	Provide financial incentives for state and local governments to provide recreation areas and opportunities.	Requires adoption of 5-year State Comprehensive Outdoor Recreation Plans to guide recreation land acquisition and development activities.
Coastal Zone Management Act (16 USC §1451 *et seq.*)	Office of Coastal Zone Management	Assist coastal and Great Lake states in preparing and implementing state coastal plans.	Requires states to adopt acceptable coastal plans as condition for continued federal assistance; plans generally designate permissible uses of coastal lands.
Floodplain Management Executive Order (E.O. 11988)	Council on Environmental Quality, Water-Resources Council and Federal Emergency Management Administration	Reduce the risk of flood loss and restore or preserve natural floodplains.	Prohibits federal agencies and licensees from building in the 100-year floodplain unless there is no practicable alternative.
Protection of Wetlands Executive Order (E.O. 11990)	Council on Environmental Quality	Minimize the destruction of wetlands.	Requires federal agencies to avoid construction in wetlands unless there is no practicable alternative.
Fish and Wildlife Coordination Act (16 USC § 661 *et seq.*)	Fish and Wildlife Service	Ensure wildlife conservation needs receive agency consideration when water- related impacts will result from federal projects.	Fish and Wildlife Service and state wildlife agencies can recommend modifications of projects to reduce impacts on wildlife habitat.

Water Resources Planning Act (42 USC § 1962 *et seq.*)	Water Resources Council	Encourage the conservation, development, and utilization of water on a coordinated basis.	Establishes River Basin commissions to coordinate water and related land development; statewide water resource planning must be consistent with these planning policies.
Agricultural Marketing Agreement Act of 1973; Agricultural Adjustment Act of 1938 (7 USC § 601 *et seq.*) (7 USC § 1281 *et seq.*)	Agricultural Stablilization and Conservation Service	Stabilizes prices, markets, and farm incomes and conserves resources.	Affects land use and crop management practices through set-aside programs, acreage allotments, and marketing limitations and subsidies.
Consolidated Farm and Rural Development Act of 1961 (7 USC § 1921 *et seq.*)	Farmers Home Administration	Finance real estate, operating, and emergency loans for soil and water conservation and rural industrialization.	Provides money for watershed and erosion protection, flood prevention, and soil and water projects.
Surface Mining Control and Reclamation Act of 1977 (30 USC § 1201 *et seq.*)	Office of Surface Mining	Protect society and environment from adverse effects of surface coal mining.	Regulates surface mining on both private and public lands and prohibits mining on critical lands.
Marine Protection, Research, and Sanctuaries Act of 1972 (16 USC 1431–1434)	Office of Coastal Zone Management	Designate marine areas as sanctuaries for conservation, recreation, or ecological purposes.	Allows only activities compatible with marine sanctuaries protection to be conducted within sanctuary boundaries.
Endangered Species Act of 1973 (16 USC § 1531 *et seq.*)	Fish and Wildlife Service	Conserve ecosystems for the use of endangered or threatened species.	Requires that federal agency actions anticipate threats to and be consistent with survival of endangered and threatened species and their critical habitats, whether or not the area is designated as critical habitat.
Watershed Protection and Flood Prevention (16 USC § 1001 *et seq.*)	Soil Conservation Service	Prevent floods, conserve and utilize water and land resources.	Helps local organizations plan for community development and forecast demands for residential, commercial, industrial and recreational facilities in a comprehensive manner.

Table 8–1 (continued)

Name (citation)	Administering Agency	Primary Purpose	Land Use Effect
		Community Development Laws	
Housing and Community Development Act of 1974 (42 USC § 5301)	Department of Housing and Urban Development	Encourage comprehensive planning for the development of human and natural resources by state, region.	Provides grants for the planning and development of community facilities and services such as housing projects and recreation.
National Flood Insurance Act of 1968 (42 USC § 4001)	Federal Emergency Management Administration	Reduce the risk of loss due to flooding.	Requires designated flood-prone communities to develop flood mitigation measures including land use, elevation and building requirements as a condition for flood insurance coverage.
Disaster Relief Act (42 USC § 5121)	Federal Emergency Management Administration	Mitigate losses from disasters and provide emergency assistance for major natural disasters.	Requires state and local governments to adopt measures which may discourage building on hazard-prone lands.
National Historic Preservation Act (16 USC § 470 *et seq.*)	Advisory Council on Historic Preservation	Protect districts, buildings, sites and objects significant to American history.	Requires that federal agency actions consider impacts of their actions on property registered in or eligible for the National Historic Register.
Federal-Aid Highway Act (23 USC § 101 *et seq.*)	Federal Highway Administration	Develop state and interstate highway system.	Provides grants to states for the construction of highway systems.
Urban Mass Transit Act of 1964 (49 USC § 1601 *et seq.*)	Urban Mass Transit Administration	Encourage the reconstruction and expansion of urban transit systems.	Provides grants to urban areas for public transportation.
Public Works and Economic Development (42 USC § 3121 *et seq.*)	Economic Development Administration	Stimulate community development through a wide range of subsidized community projects.	Provides grants to communities to develop facilities such as public works and roads.
Water Resources Development Act of 1974 (33 USC § 701 *et seq.*)	Army Corps of Engineers	Reduce the loss of life and property due to floods through dam and reservoir projects.	Provides for the construction of dams and reservoirs to reduce uncontrolled flooding and provide recreational benefits.

Pollution Control Laws			
Clean Water Act (33 USC § 1251 *et seq.*)	Environmental Protection Agency; U.S. Army Corps of Engineers	Reduce water pollution and the discharge of toxic and waste materials into all waters.	Makes grants for sewage treatment plants, which may encourage or permit growth; requires state to regulate land use practices to control pollution from indirect (non-point) sources such as urban areas; requires wetland concerns to be considered in U.S. Army Corps of Engineers dredge and fill permits.
Safe Drinking Water Act (42 USC § 300 (F))	Environmental Protection Agency	Assure public is provided safe drinking water.	Permits Environmental Protection Agency to veto federal agency and licensee projects that could contaminate the watershed of a municipality's only source of drinking water.
Clean Air Act (42 USC § 1857 *et seq.*)	Environmental Protection Agency	Reduce air pollution dangerous to public health, crops, livestock, and property.	Limits development in pristine areas, and affects siting of new industrial facilities in all areas.
Resource Conservation and Recovery Act of 1976 (42 USC § 6901 *et seq.*)	Environmental Protection Agency	Control of waste disposal and hazardous wastes.	Requires that all solid wastes, other than hazardous wastes be disposed of in sanitary landfill or utilized for resource recovery.
Rivers and Harbors Act of 1899 (33 USC § 401 *et seq.*)	Army Corps of Engineers	Protect navigation, water quality, fish and wildlife, ecology, and aesthetics of navigable waters.	Requires that effects on wildlife habitat, wetlands, historic resources, and coastal zones be considered before granting a permit for activities in navigable waters.
Deepwater Port Act of 1974 (33 USC § 1501 *et seq.*)	United States Coast Guard	Regulate the construction and operation of deepwater ports on the seas to transfer oil from tankers to shore.	Requires land-based development effects to be considered in any port license and be consistent with state environmental laws or coastal zone programs.

a large liquified natural gas (LNG) storage facility at Point Concepción, Calif., has demonstrated a need for decisions that will protect valuable resources while meeting energy needs. Various federal agencies have disagreed about how to respond to these proposals. Final decisions had not been reached in any of these cases by mid-1979.

In 1973 the Pittston Company announced plans to build a 250,000 barrel-per-day refinery and marine terminal in Eastport, Maine. Eastport, a small, rural community in northern Maine, could benefit from the increased tax base that the refinery would provide, but would also be faced with new demands for housing, public facilities, and services.

Table 8–2

Summary of State Laws Protecting Key Critical Natural Resources*

States	Resources					
	Tidal Wetlands	Nontidal Wetlands	Floodplains	Coastal areas (including Great Lakes)	Agricultural Lands	Endangered Species
Alabama (C)	P[a]			P	T	
Alaska (C)	P[b]			CMP	T,O	
Arizona			P[c]		T	
Arkansas			P[c]		T	
California (C)	CMP		P[c]	CMP	T,O	P
Colorado			P		T	P
Connecticut (C)	P[c]	P[c]	P[c]	P	T,O	P
Delaware (C)	P[d]			P[e]	T	P
Florida (C)	P[f]			P[g]	T	P
Georgia (C)	P			P		P
Hawaii (C)	P[h]		P[i]	CMP	T	P
Idaho					T	
Illinois (C)			P		T	P
Indiana (C)			P	P[j]	T	P
Iowa			P[c]		T,O	P
Kansas			P[c]		T	P
Kentucky			P		T	P
Louisiana (C)				P	T	
Maine (C)	P	P	P	CMP	T,O	P
Maryland (C)	P	P	P	CMP	T,O	P
Massachusetts (C)	P	P	P	CMP	T,O	
Michigan (C)			P	CMP	T	P
Minnesota (C)		P[k]	P[c]	P[c]	T	P
Mississippi (C)						
Missouri					T	P
Montana					T	P
Nebraska			P[c]		T	P
Nevada					T	P
New Hampshire (C)	P	P			T,O	
New Jersey (C)	P		P[c]	CMP	T,O	P
New Mexico					T	P
New York (C)	P	P[c]	P	P	T,O	P
North Carolina (C)	P		P	CMP	T	
North Dakota					T	
Ohio (C)				P[l]	T,O	P
Oklahoma					T	P
Oregon (C)	CMP			CMP	T,O	P
Pennsylvania (C)			P		T,O	P

Table 8–2 (continued)

States	Resources					
	Tidal Wetlands	Nontidal Wetlands	Floodplains	Coastal areas (including Great Lakes)	Agricultural Lands	Endangered Species
Rhode Island (C)	P	P		CMP	T	P
South Carolina (C)	P[m]			P	T	P
South Dakota					T	P
Tennessee					T,O	P
Texas (C)	P[n]			P[o]	T	P
Utah					T	
Vermont	P[p]	P[p]	P[o]		T	P
Virginia (C)	P[o]				T,O	P
Washington (C)	CMP	CMP	P[o]	CMP	T,O	P
West Virginia					T	
Wisconsin (C)	CMP	CMP	P[o]	CMP	T,O	P
Wyoming					T	

P =permits required for activities affecting the resource. *Note:* numbers indicate conditions or limitations on permit requirements.
CMP=regulated under a federally approved coastal management plan
T =preferential taxation scheme used
O =other farmland protection scheme used
(C) =denotes coastal state as defined by the Coastal Zone Management Act of 1972

*Critical natural resources are those of ecological, environmental, or cultural significance. This table reviews state regulatory activities applicable to several key resources only but is generally indicative of states' initiatives to protect critical resources overall.

[a] Activities on coastal wetlands require permits under the state's coastal regulation.

[b] Applies to state-owned wetlands and intertidal zones only.

[c] State law authorized local units to adopt regulations pursuant to state standards. In the absence of local control the state regulates.

[d] State's coastal act requires permits for industrial development in wetlands.

[e] State coastal act prohibits the siting of new heavy industry, permits required for the siting of light industry.

[f] Dredge, fill, and construction activities in certain tidal areas regulated.

[g] Activities seaward of established coastal setback lines regulated.

[h] State land use act requires permits for activities on wetlands.

[i] State land use act requires permits for activities on floodplains.

[j] Permits required for activities in lakes and their shorelands.

[k] Permits required under shorelands zoning regulation.

[l] A beach protection regulation applies to Lake Erie.

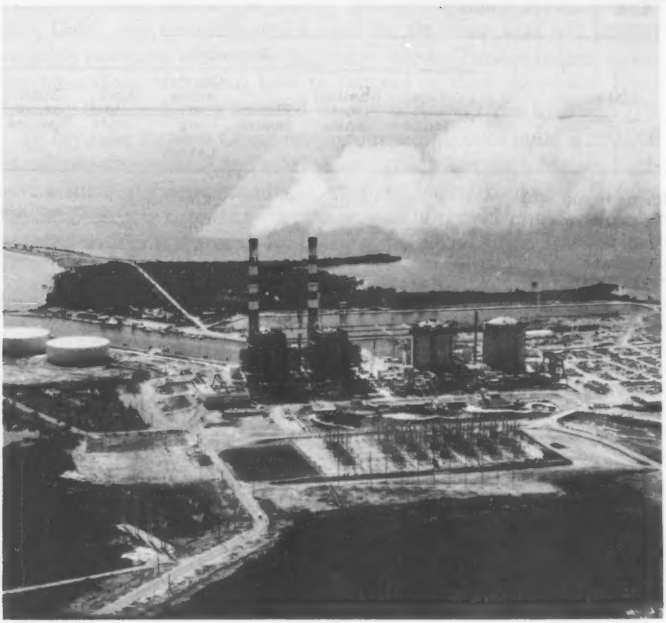
[m] Permits required for activities in wetlands within defined critical coastal areas

[n] Permits required for activities affecting public wetlands.

[o] Regulation applies only to public coastal lands.

[p] Vermont site plan review act establishes standards and requires approval for most resource disturbing activities.

Source: Bob Davis and Joe Belden, *A Survey of State Programs to Preserve Farmland*, CEQ, April 1979; Environmental Law Institute, *National Wetlands Newsletter*, Vol. 1 No. 3, Feb. 1979; Jon Kusler, *Strengthening State Wetlands Regulations*, Prepared for Department of the Interior, Fish and Wildlife Service, November 1978 (FWS/OBS—78/98); U.S. Corps of Engineers, Construction Engineering Research Laboratory, Computer-Aided Environmental Legislative Data System (Accessed April–May 1979).



Power plant at Biscayne Bay, Fla. The availability of cooling water and proximity to water transportation routes have made coastal sites highly desirable locations for new energy facilities. Photographer: Jerry Waindel.

The proposed facility would accommodate incoming crude oil tankers in the Very Large Crude Carrier class (250,000 dead-weight tons). Refined products would be loaded into smaller, 70,000 dead-weight-tons class tankers and barges for daily distribution to markets in the Northeast. The refinery, which would discharge wastewater, requires a National Pollutant Discharge Elimination System (NPDES) permit, pursuant to Section 402 of the 1972 Federal Water Pollution Control Act.[23] Application for this permit was made to EPA Region I in September of 1975.[24] Both the environmental controversy and the federal review of the Pittston proposal concentrate primarily on the potential for damage to the marine environment as a result of oil spills.

In June 1978, EPA issued a final environmental impact statement (EIS) favoring issuing a permit with stipulations.[25] Subsequently, however, the National Marine Fisheries Service (NMFS) and the Fish and Wildlife Service (FWS) presented new information and objections based on concerns about the impact on two endangered species—whales and bald eagles.[26]

In February 1978, the FWS identified the refinery site as part of the bald eagle critical habitat. The EPA concluded that the construction, operation, and risks of oil spills would endanger that habitat and that issuing the permit would therefore violate both the Endangered

Species Act and the National Environmental Policy Act.[27] Additionally, the NMFS pointed out that the migration route of a number of species of endangered whales passes through the region.

Based on these new data, EPA reversed its position and, in January 1979, denied the Pittston Company's application for a NPDES permit for the proposed Eastport refinery.[28] The Pittston Company has appealed the denial of the NPDES permit. It also has moved to exempt the refinery from the endangered species finding and will be following the review procedures newly established under the Endangered Species Act.[29] The administrative hearing regarding the permit denial will involve a number of parties, including state and federal agencies and public interest groups. The hearing will review the potential impacts of refinery construction on the marine environment, endangered species habitats, and air and water quality, as well as possible alternative sites. A final decision on construction of the refinery is not expected until 1980.

A proposal to locate a refinery at Portsmouth, Va., engendered similar conflicts that have proved equally difficult to resolve. Portsmouth is an industrial town, economically dependent at present on naval and other federal facilities and port activities. The proposed refinery would bring needed new jobs to a labor force experienced in heavy industry, would greatly add to the town's tax rolls, and would require few new public services and capital investment. New industrial construction, however, could make it more difficult for the region to comply with federal air and water quality standards and might cause serious damage to the extremely valuable fish and shellfish breeding grounds of the Chesapeake Bay.

In 1975, the Hampton Roads Energy Company proposed the refinery and marine terminal for a 628-acre site on the Elizabeth River in Portsmouth and applied to the U.S. Army Corps of Engineers for a dredge and fill permit.[30] The corps issued a final environmental impact statement evaluating the proposal in August 1977, and a final supplement analyzing alternative sites in September 1978.[31] Based on this information, the Chief of Engineers made a preliminary determination that the permit should be issued for the Portsmouth site. By that time, the project had received all necessary state permits, including the federally reviewable air and water quality permits.

The Department of the Interior (DOI) and the National Oceanic and Atmospheric Administration (NOAA), however, opposed issuing a dredge and fill permit because of the risk of oil spills. The Portsmouth site is at the mouth of the James River in lower Chesapeake Bay, the largest estuary in the United States. The bay's resources are of great commercial and recreational importance (see discussion later in this chapter). In 1977, almost half of the U.S. blue crab harvest came from the bay. The lower James River is an essential spawning ground for fin fisheries and supports the world's largest oyster seedbeds. An analysis prepared for NOAA concluded that the

construction of the refinery would result in significant increases in vessel traffic and a correponding increase in the risk of oil spills.[32]

The decision concerning the issuance of the dredge and fill permit is currently before the Secretary of the Army. Unresolved conflicts still exist between the views of DOI and the recommendations of the Army Corps of Engineers.

The proposed construction of a storage and transfer facility in California also raised important land use considerations. Public safety is a primary consideration in locating LNG facilities because, in the unlikely event that a vapor cloud escaped, an intense explosion and fire could follow. Storing and shipping this highly flammable substance requires elaborate safety precautions. Locating LNG facilities in areas of low population density is preferable from the standpoint of public safety, even though it may be less desirable from a land use perspective.

In 1974, the Western LNG Terminal Company proposed two sites for LNG terminals in California—one at Point Concepción and the other at Oxnard. The Point Concepción site is relatively isolated. The Oxnard site, however, is in an existing industrial and urban area. The total population within 4 miles of the site numbers over 100,000.[33] The safety issue has been complicated, however, by the findings in the final EIS that the Point Concepción site may be

The 95,000-ton LNG tanker **Aquarius** in 1977, built for use between Indonesia and Japan. The building of a new LNG storage facility in California would increase tanker traffic carrying this highly explosive cargo.

a potentially active seismic zone.[34] The Federal Energy Regulatory Commission is currently considering these issues in its review of the request for a permit to construct an LNG facility at Point Concepción.

Besides the difficult land use and other environmental choices posed by these three proposals, each emphasized the need to coordinate federal permit processes for critical energy facilities and to help private parties and government agencies identify environmentally unacceptable sites in advance of project commitments.

President Carter took steps to improve federal energy facility siting procedures by issuing a new Executive order in April 1979 that applies to all energy facilities except nuclear power plants.[35] Once the President determines that a proposed nonnuclear energy facility is of "critical national importance" and requires federal permits, the Director of the Office of Management and Budget (OMB) is to establish a system to coordinate review and approvals by all relevant agencies, consistent with other legal requirements, including the National Environmental Policy Act (NEPA) and CEQ regulations.

In addition, to help federal decisionmakers and industrial site planners identify the coastal areas least suitable for major energy and industrial facilities and those whose protection is most essential, NOAA, FWS, CEQ, and other federal agencies began cooperative efforts in mid-1979 to develop new coastal maps of critical areas, beginning with the east coast. The efforts are slated for completion in 1980.

Growth Impact of Inland Facilities

The siting and constructing of major inland energy extraction and production facilities is fostering rapid growth in certain rural areas. This trend will assume increasing importance; the second National Energy Plan calls for a 6 percent annual increase in coal production, from 660 million tons per year in 1978 to about 1 billion tons in 1985.[36] This growth is expected to occur in remote areas of Montana, Wyoming, North Dakota, and Colorado.

The major U.S. reserves of coal, uranium, and oil shale are concentrated in three rural inland regions—the northern and southern Rocky Mountains and Appalachia. Energy development will bring employment opportunities, economic activity, and a rapid influx of new workers to these areas. Rapid population growth could result in social disruption and failures in community services. This growth, combined with the more obvious air, water, and land use effects of energy extraction operations, and concern about how to cope with the future employment "bust"—what to do about jobs when the resource has been depleted—will put new strains on rural community life in the energy-extraction areas of the United States.

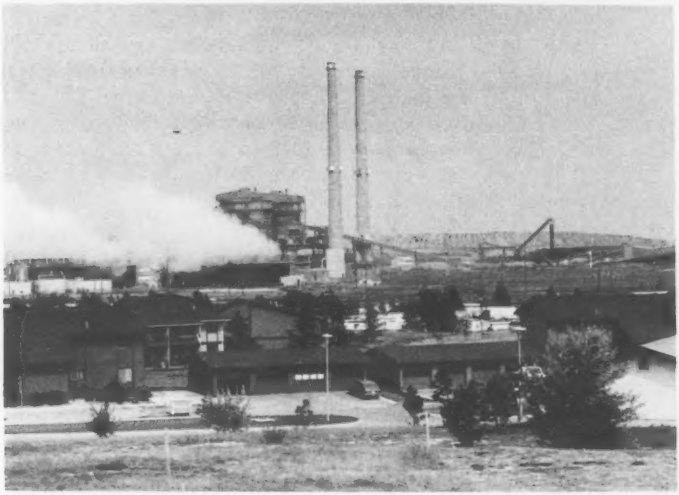
It is estimated that between 70,000 and 150,000 new coal miners will be employed in these coal reserve regions by 1985. Creating

70,000 new coal mining jobs would result in population increases of approximately 350,000 (including indirect and induced employment and families of new miners).[37] Additionally, 67 new mine mouth generating facilities are proposed for construction in conjunction with mining operations in these three inland regions by 1985. All of these plants would be beyond a 35 air-mile radius of population centers of 50,000 or more. Each will require an average of 1,500 new workers during plant construction.[38]

In the southwest Rocky Mountain region, much of the anticipated energy development—coal, uranium, and oil shale extraction operations and mine mouth power plant generation facilities—will occur along the boundaries of Indian reservations. Existing cultural contrasts, among Indians and the newcomers, threaten to exacerbate the significant community social disruption created by energy extraction.

The town of Grants, located in western New Mexico, is already experiencing many of these problems. In 1970, Grants had a population of 8,768—down 14.7 percent from 1960. By 1976, however, the area's population had increased by 19 percent with over half due to in-migration.[39] Mining has been an important activity in Grants since 1954, but the population boom from in-migration resulted from a particularly rapid surge in uranium mining.

Grants has displayed many of the typical characteristics of boomtowns. The incidence of juvenile delinquency, alcoholism, and police/citizen confrontation has risen. Public service failures have occurred, including water and housing shortages. Although Grants has received assistance from state, federal, and company sources to ease service de-



Colstrip, Mont., in 1979 is a western boomtown. The homes in the foreground were built by the Montana Power Company to house the workers at its mine-mouth power plant. Photographer: James S. MacKenzie.

ficiencies, water shortages and general community assimilation problems remain.[40]

In the northern Rockies, power plant construction and coal mining will be the major energy-related growth stimulants. The region has many small communities distant from major population centers. One of them, the town of Gillette, Wyo., where growth was induced first by oil extraction and later by coal mining and construction of a mine mouth power generating facility, has become a classic example of an energy boomtown.

In 1960, Gillette was a small ranching community of 3,500. Between 1960 and 1970, Gillette's population increased by more than 100 percent in response to oil and gas extraction activities. In the 1970s, growth continued, though at a slower rate, because of coal development and power plant construction. The community still is experiencing severe housing shortages—many people are living in mobile home units. The task of providing adequate public services, including wastewater treatment facilities and health care, has been hampered not only by rapid growth, but also by an eroding tax base. The city continues to absorb the new population, but the new industrial growth that could produce tax revenues is concentrated outside the city limits. Despite prior experience with boomtown problems, Gillette has had difficulty accommodating and assimilating its continuing growth.[41]

Bituminous coal has been a major force in the economy of Appalachia for decades. It has been the major contributor to Wise County's economy since 1890. However, mining operations in this western Virginia community have recently increased, causing population to rise 16 percent between 1970 and 1975. This rapid growth is taxing existing public services. Many health, recreation, administrative, and housing facilities were neglected during the previous years of population decline. Now, new building is being constrained by the lack of adequate water and sewer systems. With an increasing number of mining communities in the region requesting federal assistance, Wise County has little hope of receiving from outside sources the $20 million it estimates it needs to finance expansion and improvement of community services.[42]

The ability of communities like Gillette, Wise County, and Grants to respond to demands for public services and housing is complicated by market uncertainties. A lack of predictable duration for mining operations makes long-term public and private planning and development difficult. If, to obtain the greatest insured income from mining, the resource is developed and depleted rapidly, the boom and bust phenomena will be severe.

Several communities have adopted innovative approaches to dealing with these difficulties. In Mercer County, N.D., where six former farm communities are being strip mined, the communities have established a semipublic development corporation—the Mercer County Energy Development Board—to provide planning assistance to local officials. A recent review indicates that the board is effectively

assisting local and state officials in planning for and mitigating the community impacts of energy development.[43]

Several states such as Wyoming, North Dakota, Montana, and Colorado have adopted mechanisms including planning requirements and severance taxes, to finance public facilities and to meet housing needs created by energy development. Other states continue policies of tax deferral or exemptions from severance taxes that encourage energy development.[44]

Federal assistance to small inland communities to deal with energy-facility-induced growth—i.e., to expand housing, health, education, social services, transportation, and other services—has been neither coordinated nor targeted. A similar need to target funds to communities affected by energy development in coastal areas was addressed in 1976. The Coastal Energy Impact Assistance provision of the Coastal Zone Management Act (CZMA) provides funds to coastal communities to mitigate the adverse on-shore effects of new or expanded coastal energy activities.[45] (See the section in this chapter on CZMA.) Inland communities would receive similar assistance under the Inland Energy Impact Assistance Bill recently submitted by Senator Hart and endorsed by the Administration.[46]

Energy development and the siting of facilities are issues in which the federal government is heavily involved. However, in other energy-related land use matters, states, local communities, private businesses, and citizens are responsible for the crucial decisions. If land use and community planning are to effectively cope with the demands of energy development, all these entities must be involved. Despite federal assistance and state and local planning efforts to date, the following needs are still apparent:

- A process for analyzing alternative facility sites in advance of site-specific proposals by private businesses and the inevitable financial commitments these proposals involve; and
- A comprehensive, long-term, impact-assessment process leading to the design of a mitigation program that addresses all stages of the "boom-bust" cycle typical of resource-extraction activities.

PROTECTING THE COASTAL ZONE

Among the environmentally critical areas of the country, the coastal zone has long had special importance. It is a diverse natural resource that extends a total of 101,500 miles along the Atlantic, Gulf, Pacific, and Great Lakes coasts and the perimeters of Hawaii, Guam, Puerto Rico, the Trust Territories, and the Virgin Islands. It provides recreational opportunities, offers spawning grounds for a large proportion of ocean life, serves as a storm and flood buffer, and is a valuable transportation conduit. Seven of the nine largest metropolitan areas in the nation are within the zone, and more than 50 percent of the nation's population lives in counties that are, at least in part, within 50 miles of the land-sea margin.[47]

Coastal areas are an immensely valuable commercial and recreational resource. Above, a shellfish "farm."

Recently, pressures on the coastal zone environment have increased. Discoveries of nearshore and offshore mineral deposits and oil and gas reserves have stimulated industrial development. An abundance of cooling water and increased dependence on imported sources of crude oil make the coastal zone a prime candidate for power plant and refinery siting, and have increased the need for expanded port and marine terminal facilities. Nearshore areas have become the dumping sites for wastes created by both increased industrial development and increased population.

Since the early 1960s, water-based recreation has emerged as the most preferred outdoor activity.[48] Marine recreation is an economic mainstay of many coastal communities. Its strength depends on natural resources that create "marine appeal": the fragile tidelands and wetlands, islands, beaches, dunes, estuaries, and coral reefs. Yet each of these resources is seriously jeopardized by a variety of industrial, public, and private uses of the coastal margin.

The vulnerability of coastal resources and the intensity of the land use conflicts there provided an impetus for creating a federal/state land management partnership under the Coastal Zone Management Act of 1972 (CZMA).[49]

Coastal Zone Management Act

The CZMA was intended to accomplish the following major goals:

- Protecting the nation's unique and significant natural resources;
- Protecting historic and cultural resources and providing for increased recreational access;
- Managing rapid and widespread coastal development; and
- Coordinating and streamlining federal and state decisions affecting coastal resources.

The act seeks to accomplish these goals primarily through a program of federal planning grants to help the states, which have primary land-use jurisdiction, better manage their coastal resources.

The federal program seeks to give each state flexibility to adopt a management program best suited to its own needs, while also meeting certain basic national objectives Thirty-five coastal states and territories were eligibile to receive federal funding under the initial, or planning, phase of the CZMA. Between 1974 and September 1979, $70 million was distributed to these states to help them develop coastal management programs.[50] The work undertaken by states varies greatly and reflects different degrees of public concern about coastal resource management problems. Many states, including some without federal program approval, have new or strengthened regulations designed to protect critical coastal resources. To date, 15 states have received federal approval for their coastal management plans. All are now receiving second-stage, or implementation, grants on a cost-sharing basis. By September 1979, an additional four states are expected to have received program approval and will be receiving implementation grants (see Table 8–3).

The effectiveness of CZMA can best be measured by the degree of protection afforded critical resources and the ability of state programs to develop consistent methods of balancing conflicting development, protection, and recreation needs.

Protection of Critical Lands

As noted earlier (see Table 8–2), states are providing an increasing level of protection to critical resource areas. Many of these initiatives have been in direct response to CZMA requirements. Table 8–4 sum-

Table 8–3

Status of State Coastal Zone Management Programs

State	Actual or Estimated Federal Approval Date by Fiscal Year (ends 9/30)
Washington	1976
Oregon	1977
California	1978
Massachusetts	1978
Wisconsin	1978
Rhode Island	1978
Michigan	1978
North Carolina	1978
Puerto Rico	1978
Hawaii	1978
Maine	1978
Maryland	1978
New Jersey (Bay and ocean shores)	1978
Virgin Islands	1979
Alaska	1979
Guam	1979
Delaware	1979
Alabama	1979
South Carolina	1979
Louisiana	1980
Mississippi	1890
Connecticut	1980
Pennsylvania	1980
New Jersey	1980
New Hampshire	1980
Texas	1980
North Marianas	1980
American Samoa	1980
Indiana	?
Ohio	?
New York	1980
Florida	?
Georgia	Approval Unlikely
Virginia	Approval Unlikely
Minnesota	Approval Unlikely
Illinois	Approval Unlikely

Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Office of Coastal Zone Management, July 1979.

marizes initiatives coastal states have taken to protect important natural resources.

Thirty-one of the thirty-five eligible states and territories have either adopted new statutes and regulations protecting wetlands or improved implementation of existing laws as part of state coastal zone program planning. Because wetlands are prime floral and faunal habitats, most wetlands statutes provide habitat protection as well. In addition, 21 states have special management programs that deal with unique plant and animal species protection. For example, Maine has strengthened its Critical Areas Program by incorporating it in the state's approved coastal management program. One of the program's accomplishments has been to identify and register 203 important flora and fauna areas. These identifications led to the recent purchase and

Table 8–4

Summary of State Protection of Significant Natural Resources under CZMA

State	Wetlands	Floral & Faunal Habitats	Beaches & Dunes	Barrier Islands	Reefs
Alabama	X	P	P		
Alaska	X	X		X	
California	X	X	X		
Connecticut	X				
Delaware	X	X	X		
Florida	X	X	X		X
Georgia	X	X	X		
Guam	X	X	X		X
Hawaii		X	X		X
Illinois	X		X		X
Indiana	X				
Louisiana	X		P	P	
Maine	X	X		X	
Maryland	X	X	X		
Massachusetts	X	X	X		
Michigan	X	X	X		X
Minnesota	X				X
Mississippi	X		X	X	
New Hampshire		P	P	P	
New Jersey	X	X	P		
New York	X	X			
North Carolina	X	X	X	X	
N. Marianas					
Ohio	X	P	P		X
Oregon	X	X	X		X
Pennsylvania	X	P			
Puerto Rico	X	X	X		P
Rhode Island	X	X	X	X	
(Am.) Samoa					
South Carolina	X	X	X	X	
Texas	X		X		
Virgin Islands	X	X	X	X	X
Virginia	X		X		
Washington	X	X	X		X
Wisconsin	X	X	X		X

X=Pre-existing law or program incorporated in Coastal Management Program or new or expanded law or program directly attributable to CZM participation.
P=Proposed law or program to be part of CMP.

Source: National Oceanic and Atmospheric Administration, Office of Coastal Zone Management, "The First Five Years of Coastal Zone Management," (Washington, D.C., U.S. Department of Commerce, March 1979), Table II, p. 20.

protection of two sea bird nesting areas—Great Wass Island (1400 acres) and Brothers Island (11 acres)—by the Nature Conservancy.[51]

Dunes, beaches, and barrier islands provide the most desired coastal recreation opportunities. These systems, which also act as natural storm buffers, are easily destroyed by improper development activities. As Table 8–4 shows, 21 coastal states now have programs or laws that provide for the protection of their beaches and primary dunes. Barrier islands are the most extensive and most fragile of these beach-dune systems. Nearly 200 barrier islands of the Atlantic and Gulf coasts provide front-line coastal storm protection. Unfortunately,

Thirty-one coastal states have adopted wetland protection acts. Photographer: William Berg.

only 68 of these unstable sand bars remain in a natural state.[52] In 1977, President Carter highlighted the need to protect these islands by calling for the establishment of an effective plan to protect remaining unspoiled islands. Although a federal plan has not yet been completed, eight Atlantic and Gulf Coast states have taken steps to restrict development practices that accelerate the destruction of these natural buffers and to preserve those remaining undisturbed island ecosystems. Maine, for example, has adopted a Coastal Island Registry Act that clearly designates 1,300 of its 3,000 islands as public. These islands are now being protected. Rhode Island has prohibited future development on all its remaining undeveloped islands.[53]

Reefs, which are easily damaged by pollution and by silting, are being protected for their own intrinsic value and as major fish habitats in 11 states. The designation of Key Largo Marine Sanctuary in the Florida Keys was a direct result of Florida's efforts to protect its coral reefs.

Protection of Historic, Aesthetic, Cultural, and Recreational Resources

CZMA provides funds to improve management of manmade as well as natural resources, including buildings and lands of special cultural, historical, and aesthetic value. State laws and programs for the protection of these resources are summarized in Table 8–5.

Eighteen coastal states have programs to protect and restore historic areas. In six of these states the CZM program has been used to enhance the effect of these existing historic preservation laws. Five other states are using these funds to preserve or restore historic buildings and cultural sites.[54]

The potential for enhancing the city environment by reclaiming and revitalizing neglected piers and waterfronts is great. In 1978, the Office of Coastal Zone Management (OCZM) approved seed-money grants for local demonstration projects in more than 30 coastal communities (see Table 8–5). These small, $25,000 to $30,000, grants are intended to attract interest in, and additional funds for, harbor revitalization projects. A majority of the projects are intended to provide waterfront access and recreation, though some are aimed at historic preservation, economic development, harbor expansion, and other goals.

States have already made considerable progress in providing public access to the coast. Nine states now mandate shoreline access as a condition for permits to build new structures in the coastal zone. Five states have open beach laws that provide the public with the right to use all beaches within the state's defined "beach" boundaries. In California, for example, the state has made public access to and along the state's shoreline a condition of new permits for shoreline development under the California Coastal Act. In the Malibu area alone, more than 125 access easements have been secured. Delaware has undertaken legal research to identify areas where private development has encroached on the public domain. Rhode Island is conducting a similar analysis with the aim of re-establishing more than 70 public rights-of-way (see Table 8–5).

Planning and Management

Protecting critical resources requires proper management of coastal development. Federal and state agencies have for some time been particularly concerned about controlling development in hazardous areas. Twenty states control development in erosion-prone shoreline areas, primarily through setback requirements or beach and dune preservation laws (see Table 8–6). Many states have also sought to achieve better floodplain management by coordinating coastal zone program requirements with those of the National Flood Insurance Program. Four states are using their coastal management programs to expedite compliance with the Federal Insurance Administration's (FIA) minimum requirements, and three are proposing to do so. The zoning and setback requirements of 11 states go beyond the minimum FIA requirements.[55]

Table 8–5

Summary of State Protection of Historic and Cultural Resources under CZMA

State	Required Dedication of Access	Open Beach Laws or Court Action	Protection/Restoration of Historic and Cultural Resources	Protection of Scenic Areas/ Provision of Visual Access	Urban Waterfront Projects
Alabama	P		P	P	
Alaska	X		X		
California	X		X	X	
Connecticut			X		New Haven, Stamford, Norwalk
Delaware		X			Wilmington, Newcastle County
Florida					Miami, Sarasota
Georgia			X	P	Brunswick, St. Mary's
Guam		X	X		
Hawaii	X	X	X	X	Honolulu
Illinois			X	X	Chicago-Waukegan
Indiana					
Louisiana			X		Moon Walk, Lincoln Park
Maine				X	Calais South Portland, Vinalhaven
Maryland	X		X		Cambridge Creek
Massachusetts			X	X	
Michigan			X	X	Detroit
Minnesota					Duluth
Mississippi					Gulfport
New Hampshire	P P			P P	Portsmouth, Exeter
New Jersey	X			X	Jersey City
New York			P	X	Buffalo
North Carolina			X		Wilmington
N. Marianas					
Ohio					
Oregon		X	X	X	
Pennsylvania	P		P		
Puerto Rico	X		X		San Juan
Rhode Island		X	X		
(Am.) Samoa					
South Carolina	X		X		
Texas		X			
Virgin Islands	X	X	X	X	
Virginia					Alexandria, Norfolk, Newport News, and Virginia Beach
Washington			X	X	Seattle
Wisconsin	X			X	Milwaukee, Kenosha

X=Pre-existing law or program incorporated into CMP or new or expanded law or program directly attributable to CZM participation.

P=Proposed law or program to be part of Coastal Management Program.

Source: National Oceanic and Atmospheric Administration, Office of Coastal Zone Management, "The First Five Years of Coastal Zone Management," (Washington, D.C., U.S. Department of Commerce, March 1979) Table V, p. 39.

Table 8–6

Summary of State Laws Affecting Management of Coastal Development

(by type of activity or area affected)

State	Erosion-Prone Areas	Floodplains	Subsidence and/or Saltwater Intrusion	Energy Facility Siting	Priority to Water-Dep. Uses	Locating Dredge Disposal Sites	Offshore Oil & Gas; Sand & Gravel Extraction
Alabama	P	P	X		X		
Alaska	X	X	X	X	X		X
California	X		X	X	X		X
Connecticut					P	X	
Delaware	X				X		
Florida	X			X			
Georgia	X		X		X		X
Guam		X					X
Hawaii	X	X	X		X		X
Illinois		X				X	X
Indiana		X				X	X
Louisiana	P	P	P	X		P	P
Maine	X	X			X		X
Maryland	X	X		X	X		
Massachusetts	X	X		X	X	X	X
Michigan	X	X			X		X

Minnesota		X			X	X
Mississippi				P	P	
New Hampshire		X	P	P		P
New Jersey	X			X		X
New York	P	P		X	P	X	X
North Carolina	X	X	X	P	X	P	
N. Marianas						
Ohio	P	P		X	X	X
Oregon	X	X			X	P	X
Pennsylvania	X	X		P			X
Puerto Rico	X	X			X		
Rhode Island	X	X				X	X
(Am.) Samoa							
South Carolina	X				X		X
Texas		X	X			P	P
Virgin Islands	X	X	X	X	X		
Virginia							
Washington	X	X		X	X	X	X
Wisconsin	X	X		X	X	X	X

X = Pre-existing law or program incorporated into CMP or new or expanded law or program directly attributable to CZM participation.
P = Proposed law or program to be part of CMP.

Source: National Oceanic and Atmospheric Administration, Office of Coastal Zone Management, "The First Five Years of Coastal Zone Management," (Washington, D.C., U.S. Department of Commerce, March 1979) Table IV, p. 31.

Regulation of certain economically important but potentially environmentally damaging activities is also needed in the coastal zone. Exploiting valuable offshore mineral reserves—sand and gravel, and oil and gas—can threaten other coastal resources. Twenty states have measures regulating offshore sand and gravel mining and/or oil and gas extraction. Three more states are proposing such measures (see Table 8–6).

As noted earlier, problems with siting of energy facilities in the coastal zone have focussed attention on the many land use conflicts whose resolution is delayed in the absence of a coordinated management approach. Coordinated and effective review of proposed energy facilities requires effective state as well as federal siting procedures. Twelve states have adopted programs to improve siting procedures (see Table 8–6). These programs include expedited permit processing, advance industrial site designations, advance purchase programs, and state pre-emption of local decisions in siting energy facilities in the coastal zone. In addition, amendments to the CZMA have provided funds for states to alleviate the growth impact of new energy facilities. The Coastal Energy Impact Program (CEIP), added to the CZMA by amendments in 1976, gives federal assistance to coastal states and local governments to meet community and environmental needs resulting from coastal energy development.[56] The Outer Continental Shelf Lands Act Amendments of 1978 significantly amended the CEIP.[57] Whereas the original program emphasized loans from a revolving fund, the amendments provided a much larger amount for grants: $200 million a year. In 1979, $27.5 million in grants were allocated for distribution to eligible states.[58]

Coordination of Federal and State Actions

The CZMA has encouraged states to improve the coordination and simplification of governmental regulatory procedures. In the 1970s, federal interest in the use and protection of coastal resources greatly expanded. Executive orders on wetlands and floodplains,[59] the National Flood Insurance Program,[60] the Deepwater Port Act of 1974,[61] the Fishery Conservation and Management Act of 1976,[62] and the Outer Continental Shelf Lands Act Amendments of 1978 [63] all directly affect the long-term use of the nation's coastal resources. Federal highway, community development, recreation, fish and wildlife, and a host of other programs indirectly influence coastal protection efforts. States have programs as well.

The CZMA has evolved as a major opportunity for states to help coordinate these programs. The federal consistency provisions under CZMA [64] allow states to review federal agency activities (except those on federal lands), to insure that they conform to federally approved state coastal management plans. Federal agency activities that states may review include development projects, federal licenses and permits, Outer Continental Shelf plans, and financial assistance to communities. The CZMA provides that the federal government may over-

ride a state's decision that a project is inconsistent only if the project is deemed to be of national importance.

Considerable controversy between federal agencies, states, and other affected parties delayed the issuance of final regulations to implement these coordination provisions. Thus, although the CZMA was passed in 1972, regulations were not promulgated until 1978.[65] Much of this controversy has centered around the definition of projects of "national interest." This was a principal issue in a suit brought by the American Petroleum Institute (API) against the California Coastal Management Program.[66] API contended that California's program did not adequately recognize that energy projects might, as a matter of overriding national interest, have to be located in the coastal zone (see CEQ's Ninth Annual Report). Because procedures for balancing of conflicting interests in the siting of facilities is a requirement of CZMA, a district court dismissed this claim that energy projects should be placed above other national interest considerations—such as public welfare or resource protection—and held that states were not required expressly to "accommodate" energy facilities. API has appealed the decision to the U.S. Court of Appeals.[67]

Largely as a result of the delays in issuing final regulations, the consistency provisions have proved to be neither a strong incentive for states to participate in the CZMA program nor a broad new method for states to coordinate federal actions affecting the coastal zone. Thus far, the benefits have largely been increased information exchange and discussion between states and federal agencies. In some cases this has produced early adjustments in project design and avoided delay-causing conflict later on.

Recent legislative actions have sought to strengthen federal-state consistency coordination. These include:

- The Deepwater Port Act—This prohibits the Secretary of Transportation from issuing a federal license for a deepwater port unless the governor of the coastal state approves the license. Moreover, no license may be issued unless the adjacent coastal state to which the deepwater port will be connected by pipeline has, or is in the process of developing, an approved Coastal Management Program under the CZMA;[68] and
- The Outer Continental Shelf Lands Act—This Act, as amended, requires the Secretary of the Interior to consult with and consider the recommendations of states with respect to the size, timing, and location of a proposed lease sale or with respect to a proposed development plan. Where states have approved coastal management programs, the statute explicitly requires federal Outer Continental Shelf actions to be consistent with state programs.[69]

Examples of coordinated government decisionmaking are still few, however, and many federal programs fail to consider the overall effects of their actions on coastal resources. Limited experience with the application of the federal consistency provisions leaves many unanswered questions about their effect on state and federal agencies.

Shortcomings of Protection Efforts

The accomplishments to date under the CZMA are significant, but weaknesses in this innovative land use management approach do exist, including variations in state programs and the fact that some states have no programs at all. The Chesapeake Bay illustrates many of these shortcomings all too clearly.

The Chesapeake Bay, the largest estuary in the United States, extends about 200 miles from Cape Henry, Va., to the mouth of the Susquehanna River in Maryland. Including its tributaries, the bay's shoreline measures about 8,100 miles. Tidal shoreline accounts for 4,600 miles, of which 3,400 are in Maryland and 1,200 in Virginia. The bay is characterized by large expanses of fresh, brackish, and saltwater marshes. These wetlands serve as a habitat and nutrient source for immense numbers of invertebrates, fish, birds, and mammals. In 1977, the bay's commercial fisheries had a dockside value of $86.1 million and accounted for 40 percent of U.S. oyster landings, 44 percent of the blue crab landings, 15 percent of the soft-shell clam landings, and approximately 90 percent of the soft-shell crab harvest. Expenditures associated with recreational boating, swimming, and fishing activities contribute millions of dollars each year to the economies of Virginia and Maryland.[70]

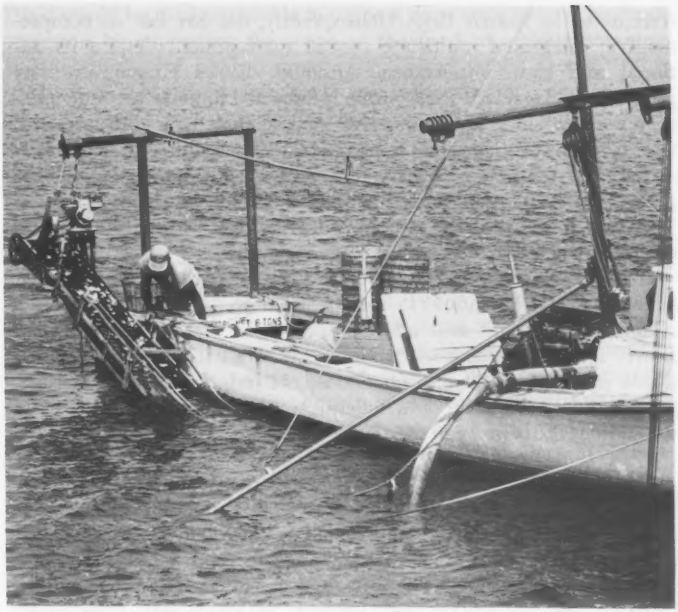
But the degradation of the bay's environment threatens these resources. Toxics, such as the Kepone that still persists in the James River; municipal sewage, estimated at 400 million gallons per day; and oil from nearly 800 petroleum spills per year, have closed shellfish areas, reduced fish catches, and destroyed valuable wildlife.[71]

Man's development activities are also accelerating natural degradation processes. More than 400 miles of bay shoreline have been identified by the Corps of Engineers as critically eroding.[72]

Development pressures on the bay's shorelines are intensifying. Between 1970 and 2020, the land used by industry is expected to increase by 50 percent, and land committed to residential use is expected to double.[73] The movement of goods into the bay's two major ports, Baltimore and Hampton Roads, is expected to increase and will require the deepening of major ship channels.[74]

Concluding that these pressures "if uncontrolled, will lead to the degradation of the whole bay area," Congress in 1976 directed EPA to conduct an in-depth study of the bay, its resources, and its management.[75] The goal was "to protect and preserve the quality of the Chesapeake Bay by effectively managing its uses and resources." In implementing this study EPA has concentrated its research in four areas: assessment of the bay's biological health; the identification of toxic or hazardous substances; assessment of the role of submerged grasses in bay ecology; and review of baywide management alternatives. Funded since 1976 at $5 million per year, the EPA study has not yet addressed the problems of baywide management.

The apparent need to initiate a federal Chesapeake Bay program highlights several weaknesses of CZMA. First, a voluntary CZMA



Clam fishing in Chesapeake Bay accounts for 15 percent of the total national soft-shell clam catch. Photographer: Bob Williams.

program, dependent on state initiatives, permits gaps in long-term protection of key coastal resources simply because some states may not have an approved program. Second, the federal consistency provisions of the act have so far proven ambiguous and difficult to administer. States such as Maryland have not fully exercised the management-coordinating authority delegated to them under the act. Finally, what constitutes protection of national interest resources, such as the Chesapeake Bay, has not been well defined.

Maryland and Virginia share both the wealth of the bay and the management responsibilities. Major sectors of both states' economies are linked to the bay, yet neither state has adopted strong initiatives to preserve and protect the bay's resources. Although Maryland received federal approval for a Coastal Management Plan in September 1978, this approval was conditional on the development of a detailed set of management guidelines to insure that new coastal projects will comply with state coastal policies. The state's initial response was slow, but with the recent passage of legislation establishing a Tidewater Administration, it is anticipated that the state will begin to exercise more fully the authority available to it under CZMA. Virginia, on the other hand, despite 4 years of federal support of program development, was unable to pass coastal zone legislation. As a result, federal coastal zone funding to the state was

terminated in March 1979. Consequently, the bay has no comprehensive, integrated multistate coastal management despite its national and state importance. Although EPA's Chesapeake Bay program management study group is expected to make recommendations as to possible comprehensive management strategies later this year, the basic management initiative will remain with individual states. The voluntary CZMA framework will continue to be the primary planning stimulant available, providing Maryland and Virginia (if it passes the necessary legislation) with the funds and authority needed to manage the bay.

CZMA requires re-authorization in 1980. As part of the re-authorization process, amendments are expected to be submitted by the Administration that will address the major weaknesses identified above. The debates that will undoubterly be a part of the re-authorization process will have implications, not only for the Chesapeake, but also for local, state, and federal land management approaches throughout the country in the 1980s.

PRESERVING THE NATIONAL HERITAGE

Less tangible than the coastal zone, but nonetheless in special need of protection in an era of rapid change in land use patterns, are lands of unusual historic, scientific, and cultural value to the nation. Defining and identifying such areas is no small feat. One man's unique ecosystem is often another man's swamp, and one man's cultural landscape is often another's rundown row house. However, the need to preserve a variety of natural and manmade environments has been increasingly evident over the past several years. Many "preservationists" are broadening their focus to include not just preservation of historic buildings, but preservation of areas of unique ecological diversity and culturally unique landscapes and villages as well.

Natural Area Conservation

The new National Heritage Policy Act, to be submitted to Congress by the Administration, addresses both these new interests. It would expand the National Register of Historic Places to encompass neighborhoods and cultural landscapes, and would create a National Register of Natural Areas to include ecological and geological resources of national, state, and local significance. Resources listed on the National Register of Natural Areas would be protected from federal undertakings that may have adverse effects on the resource by expanding the scope of federal agency planning to include consideration of natural heritage values.

To complement existing historic preservation efforts in the states, the legislation would establish a network of voluntary state natural heritage programs to inventory, assess, and plan for the protection of the full range of ecological and geological resources located within their boundaries. Money from the Land and Water Conservation

Fund would be made available to support these state natural heritage programs by expanding the scope of the fund to include planning and acquisition of natural areas with limited public access.

Much of the activity in natural area preservation is occurring at the state level. With the assistance of the Nature Conservancy, 20 states and the Tennessee Valley Authority have begun Natural Heritage Programs to preserve ecological diversity. This public/private effort has centered around systematic inventorying of ecological elements for all types of ecosystems and species habitats. In South Carolina, Ohio, and Mississippi the legislatures have enacted protection tools recommended by the Heritage Program and many additional states are in the process of adopting such tools.[76] Natural area protection tools include registration of natural areas, which gives official recognition to their special value and permits voluntary protection agreements with landowners, and dedication of lands to a nature preserve system through outright gifts of property, purchase of development rights, acquiring conservation easements, and related methods. Some special areas protected as a result of State Heritage Programs include Stevens Creek in South Carolina, Hungry Beach in West Virginia, and Rockaway Cedar Forest Preserve in Oregon.[77]

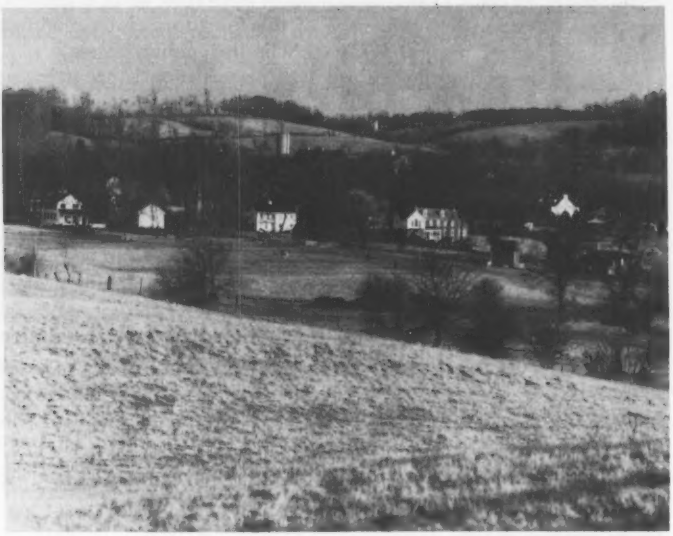
Rural Preservation

Tied to natural heritage protection is the growing interest in rural conservation. As explained by the National Trust for Historic Preservation:

> *Rural conservation* is the protection of the countryside and includes the preservation of buildings and villages of cultural significance, the economy, and social institutions. A functional and harmonious relationship exists between a rural area's buildings and villages and their surrounding open space because traditionally the setting, types, and design of rural developments were heavily influenced by topography, climate, and indigenous building materials. To preserve this relationship, rural conservationists must concern themselves with the protection of such open space resources as farmland, forests, wetlands, and wilderness.[78]

The Trust is beginning a new rural project with four goals: to protect buildings, structures, and villages integral to the countryside; to protect the contryside itself; to encourage compatible economic development that insures the continued viability of rural areas; and to promote the well-being of the present rural population.[79] This 3-year project will produce information sheets on such rural preservation topics as visual analysis, establishing easement programs, and organizing broad-based local preservation and conservation organizations. It will also provide technical assistance to many rural communities in the mid-Atlantic region, with four chosen as model areas for more intensive assistance in the use of innovative protection techniques.

The in-depth assistance will be based substantially on the Trust's Midwest Regional Office's Main Street Project, which has been designed to bring about the economic revitalization of three small



Two rural preservation efforts of the National Trust for Historic Preservation. Above, Waterford, Va., where the Waterford Foundation, with help from the National Trust and other organizations, has been striving to protect both the village center and the rich surrounding farmland through planning and creation of easements. Below; the Main Street of Madison, Ind., where harmoniously designed 19th century buildings are obscured by modern, oversized signs. The NTHP is providing assistance in improving both the appearance and economic health of the town center. Photographers: Samuel N. Stokes (above) and James L. Ballard (below).

towns—Hot Springs, S.D.; Galesburg, Ill.; and Madison, Ind.—through the restoration of their old commercial centers. Under this project, business groups organized Main Street promotions and helped restore building facades and design commercial signs. Consultants in urban design, architecture, landscape architecture, real estate, economics, and marketing all took part in revitalizing the three communities. Project managers were responsible for initiating implementation of the consultants' recommendations.[80]

A recent example of federal efforts to protect rural communities and landscapes is the acceptance of more than 7,000 acres of private scenic easements by the Secretary of the Interior on rural lands in the Green Springs Historic District of Virginia. The area is a national historic landmark whose characteristics are considered "threatened" by vermiculite mining activity.[81] The Green Springs example represents the largest area in the United States protected by donations of easements for historic preservation purposes.

Traditional Historic Preservation

While the scope of preservationist activities is broadening, more traditional preservation efforts continue. Tax approaches are becoming increasingly important in protecting historic buildings.

Previous CEQ annual reports (see especially Eighth Annual Report, 1977) have described federal programs that directly aid traditional historic preservation activities. Among them are matching grants to states from the Heritage Conservation and Recreation Service (HCRS), loans from the National Trust, and tax incentives and disincentives under the Tax Reform Act of 1976.[82]

From March 1977 through June 1979, more than 900 historic preservation rehabilitation *projects* in 42 states had been certified by HCRS as eligible to use tax incentives under the 1976 Act (see Table 8–7 for description of incentives). Nearly 1,100 single *buildings* had been certified as contributing to the significance of their districts and are therefore eligible as well. Further, more than 70 state and local statutes were certified by HCRS, a necessary step for buildings in state and locally designated districts to qualify for the tax incentives. In sum, the tax incentives resulted in an investment of more than $420 million in predominantly private renovation of buildings—such as the Bellevue-Stratford Hotel in Philadelphia and the Chrysler Building in New York City—as well as many smaller residential, commercial, and industrial undertakings.[83]

Many preservationists believe that extensive private investment is necessary if preservation efforts are to reach any magnitude. They therefore supported a provision that passed as part of the Revenue Act of 1978 which provides a new tax incentive—a 10 percent investment tax credit—to encourage the rehabilitation of older buildings.[84] This Act also amended the 1976 Act in several important respects. Table 8–7 summarizes the current federal tax incentive programs affecting preservation.

Table 8–7

Federal Tax Incentives for Rehabilitation of Historic and Older Buildings

Tax Treatment	Law	Purpose	Rehabilitation Time Frame	Properties Which Qualify	Parties Eligible
Amortization	Section 2124 of Tax Reform Act of 1976 as amended.	Allows deductions of rehabilitation expenses over 60-month period rather than over useful life of property.	June 14, 1976 to June 15, 1981.	National Register individually listed depreciable buildings.	Fee simple owner.
				Certified depreciable buildings located within National Register historic districts.	Lessee of 30 years or more.
				Certified depreciable building located in certified local district designated under approved statute.	Life tenant owner.
Accelerated Depreciation	Section 2124 of Tax Reform Act of 1976 as amended.	Allows larger tax deductions than straight-line depreciation for entire basis of property during early years of property's useful life.	June 30, 1976 to July 1, 1981.	Same as above.	Fee simple owner.
Investment Tax Credit	Section 315 of Revenue Act of 1978.	Allows 10% of rehabilitation expenses to be deducted directly from taxes owed by taxpayer.	After October 31, 1978.	Industrial or commercial building 20 years or older whose rehabilitation life is 5 years or more.	Fee simple owner.
				Twenty years must have elapsed since construction or prior rehabilitation.	Lessee with owner consent except for lessee of government-owned building.

Source: Office of Archeology and Historic Protection, The National Register Division, Heritage Conservation and Recreation Service, U.S. Department of the Interior, March 1979. (unpublished).

States and municipalities are also providing increasing tax relief to historic properties. In property tax relief alone, current state and local tax statutes cover a range of approaches:

- Exemption from property tax;
- Credit against property tax;
- Abatement of property tax;
- Assessment based on actual use;
- Assessments to reflect encumbrances on property; and
- Deferral of increase in assessment due to rehabilitation.[85]

On the Horizon: A New Department of the Interior Policy Plan

Late in 1979, the Department of Interior expects to issue a National Historic Preservation Policy Plan on how to foster historic and cultural preservation. The plan, based on input from 800 private and public agencies throughout the nation as well as information gathered at regional meetings with preservationists, will address eight priority policy issues, including:

- Improving the system for identifying, evaluating, and recognizing cultural properties in urban and rural areas, with particular attention to National Register criteria;
- Collecting more detailed information on the effect of historic preservation activities on employment, energy consumption, urban revitalization, displacement, etc., so that public sector strategies can better encourage private investment in recycling urban and rural historic properties for economically viable uses; and
- Determining how the current historic preservation grants-in-aid program can be most effectively used to encourage preservation.[86]

URBAN REVITALIZATION

Although more people are leaving the nation's older central cities than are moving to them, there is nevertheless renewed activity to revitalize many of these cities to meet changing commercial and residential needs. Although traditionally these needs were accommodated by tearing down existing structures and building new ones, during the past several years interest has increased in rehabilitation rather than replacement of structures.

Revitalization through rehabilitation is being fostered by a broadened historic preservation movement, by redirected government programs, and by the independent activities of many private individuals or organizations to reuse old buildings for business and residential purposes. The growing trend to conserve urban resources has important benefits in terms of conserving energy, materials, and cultural expression and improving a city's economic base. It can also create problems involving displacement of minorities and the poor from low-income neighborhoods.

COMMERCIAL REVITALIZATION

The move to convert old and sometimes abandoned properties to new commercial uses, as in the cases of Ghirardelli Square and The Cannery in San Francisco, has a number of causes. According to the Advisory Council on Historic Preservation, "Adaptive use is popular because of new political, legal, social, and economic forces which favor the widespread retention and reconditioning of buildings, especially in the commercial sector." [87] These forces include: lower initial costs for acquisition and construction, lower or comparable operating costs, overall lower energy costs, and new government policies on tax incentives and rehabilitation programs that encourage reuse.

For example, a pioneer project in Baltimore called "shopsteading" (a variation of "homesteading") is combining commercial revitalization with historic preservation. In December 1977, the city began selling old commercial properties for $100 to buyers who agreed to bring them up to code and to operate them as businesses for at least 2 years. Most are in the Union Square Historic District and must meet the renovation standards required by the district.[88]

A recent study of four cities documented the multiple contributions of historic preservation to urban revitalization. Among them are rises in private and public investment; decreases in crime rates; and increases in retail sales, property values, and property tax revenues.[89]

Several federal programs are encouraging commercial renovation and revitalization of downtown areas. The Department of Housing

Ghirardelli Square in San Francisco was one of the first major commercial revitalization efforts in the nation. This highly successful shopping complex was formerly a candy factory. Photographer: Roger Sturtevant.

and Urban Development's federal Urban Development Action Grant (UDAG) program, for example, is being used to support economic revitalization in downtowns, including those of significant historic or cultural importance. In San Antonio, Tex., the Alamo Plaza historic district is the focus of a large-scale redevelopment project to rebuild the downtown, combining private investments with UDAG monies.[90]

RESIDENTIAL REVITALIZATION

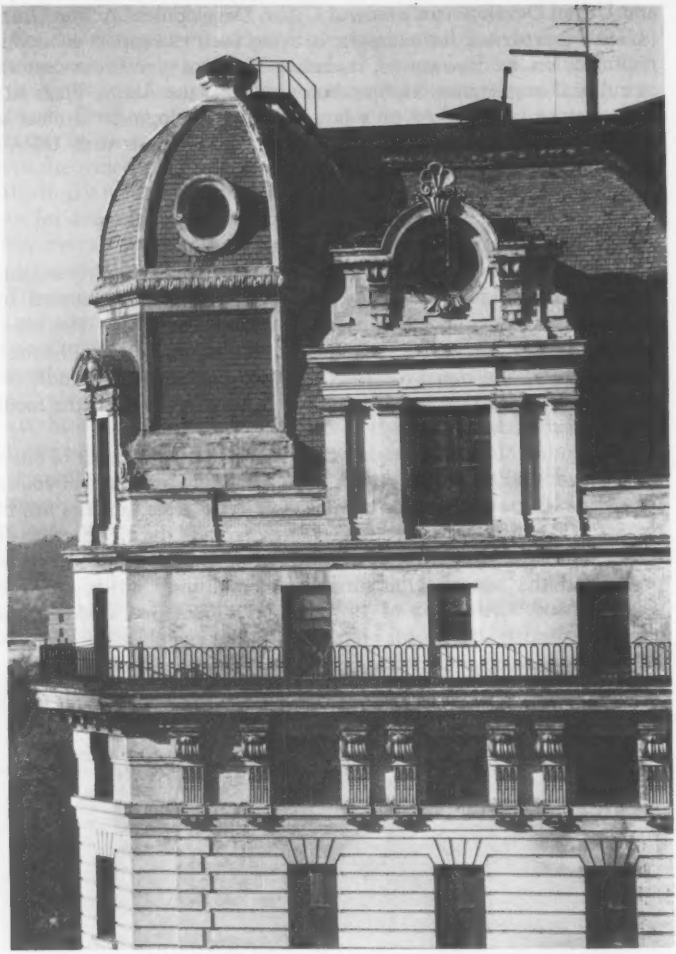
In many cities, young middle-class professionals are renovating buildings in rundown city neighborhoods—generally occupied by low- and moderate-income minorities—for residential use. The trend is quite visible in cities like Washington, Baltimore, Boston, Philadelphia, Atlanta, and San Francisco. This movement of the middle-income residents into certain United States neighborhoods is the focus of a new urban debate.

Case studies of specific neighborhoods in a limited number of cities have shown that these new residents are generally professional young couples or single individuals without children whose incomes are in the $10,000 to $30,000 range.[91] They are choosing the city because of proximity to work; cultural amenities; better housing quality for the price; and the historical, architectural, or ethnic character of the neighborhood.[92] A survey of 44 cities has shown that middle-class minorities and couples with children are also members of the new urban group in certain neighborhoods. For example, 40 percent of the neighborhoods surveyed showed increased numbers of families with children after rehabilitation.[93]

The movement does not yet represent a general "back-to-the-city" shift, however. In fact, in a 1978 Urban Institute report, aggregate national statistics for all cities showed that in 1973 and 1974, 70 percent of those moving into older homes were moving from elsewhere in the central city.[94]

The impact of such change can be negative as well as positive. The most controversial effect attributed to this trend is displacement of low- and moderate-income minority residents. A study of 30 cities found that 48 percent of the neighborhoods were predominantly black before new middle-income residents moved in, while only 2 percent remained so afterwards.[95] Other studies have shown a similar displacement of renters, blue-collar workers, the unemployed, and the elderly.[96] Such individuals may be forced to move when their landlord sells their building to a renovator.

The overall significance of these statistics for urban populations is unclear, however. One recent study made an "upper-bound maximum estimate" that in most large cities no more than 100 to 200 households annually are likely to be affected by displacement, and no more than a few thousand in the most extreme cases.[97] But, as HUD's own report on displacement states, "the variations in definitions of displacement . . . and the lack of systematic comparable data, com-



The century-old Willard Hotel in Washington, D.C., was formerly slated for demolition in a downtown urban renewal project. It is now being rehabilitated.

bine to make it virtually impossible to estimate with any confidence the number of households displaced each year, and even more difficult to place a number on those displaced as a result of private investment." [98]

Before the magnitude of the problem can be assessed, more must be known about what happens to those displaced. There is some indication, for example, that many find comparable or better housing nearby, and that some displaced homeowners use their sale proceeds to fulfill expressed desires to move to suburbia.[99] It there-

fore cannot be assumed that displacement always constitutes a negative experience. The new residents can also bring important benefits to a city neighborhood, reversing trends toward deterioration and abandonment of housing, raising housing values for long-time residents, bringing new business to local merchants, and fostering racial integration.

To some degree, the debate over displacement involves differing philosophies about the future role of the city. According to one view, many large central cities are destined to become regional centers for financial and specialized business services, employing highly trained middle- and upper-income professionals. Resettlement of older areas by middle- and high-income households should therefore be encouraged through public and private incentives. Further, because these same cities continue to lose to outlying areas the less-skilled jobs currently held by lower-income and minority residents, public and private programs should encourage the out-movement of city minorities to those suburban employment centers instead of subsidizing the status quo and seeking to resist natural urban changes.[100]

Other observers stress the importance of maintaining cultural, social, racial, and economic diversity within our cities. They note that encouraging an overwhelming influx of the white middle-class and forcing out the current residents could eventually turn cities into sterile, monolithic enclaves[101] shifting many problems to the inner suburbs. These observers argue that the city should continue to supply homes, jobs, and neighborhoods for a variety of people. Thus, although middle-class whites should not be prevented from moving in, some believe that programs should insure security for existing residents and help them benefit, not suffer, from urban rejuvenation. The National Urban Coalition, for example, has urged government at all levels to: provide information to residents needing housing counseling, increase resources for rehabilitation, improve legislative protection for the disadvantaged, and improve use of existing government programs and policies to promote neighborhood diversity.[102]

Late in 1978, HUD reaffirmed its commitment to support rehabilitation efforts for historic buildings through the Community Development Block Grant (CDBG) program.[103] Cities can use their block grants to acquire and rehabilitate historic properties for low- and moderate-income housing and to convert historic properties to neighborhood facilities. Funds can also be used to match the historic preservation grants made by HCRS to the states and passed to the cities. Preservation-related activities supported by CDBG funds range from cultural resource surveys in Louisville, Ky., and Indianapolis, Ind., to rehabilitation of street facades in Tempe, Ariz., and Gloucester, Mass.[104] Because HUD is aware of problems of displacement, however, it has also recently funded an Urban Coalition counseling services demonstration project to prevent or minimize the displacement effects in three cities.[105]

The National Commission on Neighborhoods, in its March 1979 report to the President, also urged public and private actions to

maintain neighborhood diversity and assist current residents. The Commission's Neighborhood Reinvestment Task Force recommended:

- Legislation to eliminate effects of "redlining" such as home-mortgage and home-insurance discrimination;
- An emergency home-purchase program to help renters immediately threatened by condominium conversions to buy their units;
- A requirement that 75 percent of CDBG monies benefit existing residents of communities that are deteriorating due to loss of investment; and
- A policy that one-third of all UDAG funds be allocated to neighborhood projects and that UDAG criteria favor neighborhood stabilization and improvement programs for current residents.[106]

At present, a number of preservation groups and city governments are cooperating to help low-income residents stay in neighborhoods that—in part due to historic preservation efforts—are experiencing an influx of middle-income buyers. The Foundation for San Francisco's Architectural Heritage, for example, is guaranteeing home improvement loans with low interest rates and long repayment periods for low-income owners of architecturally important buildings. An organization called Historic Denver is rehabilitating abandoned houses and selling them to the former tenants. The National Trust for Historic Preservation has made several low-interest loans to groups conserving residential neighborhoods of low-income families and determining the feasibility of rehabilitating old buildings for low-income housing (e.g., in San Francisco's Chinatown).[107]

TRANSPORTATION POLICY

PROPOSED SURFACE TRANSPORTATION ADMINISTRATION

In November 1978, Secretary of Transportation Adams proposed to combine the Department of Transportation's (DOT) Federal Highway Administration and Urban Mass Transportation Administration into a single agency to be called the Surface Transportation Administration (STA).[108]

In addition to operating more efficiently, the new STA would carry out new Congressional mandates that redirect highway and transit programs from new construction to more efficient use of the existing transportation network.[109] The STA should be especially important to urban areas that cannot afford expensive projects and want to improve their existing highways and bus systems. Major projects, however, would still be funded by the Highway Trust Fund.

COMBINED TRANSIT AND HIGHWAY CORRIDORS

In recent years, state and local governments have asked DOT to consider approving transit and highways in the same corridor. For example, Atlanta has I–75 and I–85 next to its rail system

(MARTA). The Washington, D.C. area is building I–66 with the subway system, METRO, in the middle.

DOT has proposed a new Major Urban Transportation Investment Policy that would require a Cost Effectiveness Analysis of Alternatives for projects in urban areas.[110] The new policy will improve DOT's ability to weigh the costs and benefits of proposed transit and highway projects. The analysis of alternatives will include consideration of social, economic, and environmental goals and can be conducted as a part of the environmental review process for the proposed projects. DOT expects that the analysis of both highways and transit will be needed for about 40 to 50 urban corridors throughout the country.

UNUSED HIGHWAY LAND

Atlanta, Boston, and New Orleans are benefiting from a new DOT program allowing states that cancel proposed highways free use of the land for public projects. Boston, which canceled parts of I–95 and I–695, expects to use the right-of-way for a rail line, and may also use it for a community college, private and public housing, commercial and industrial development, and parks.

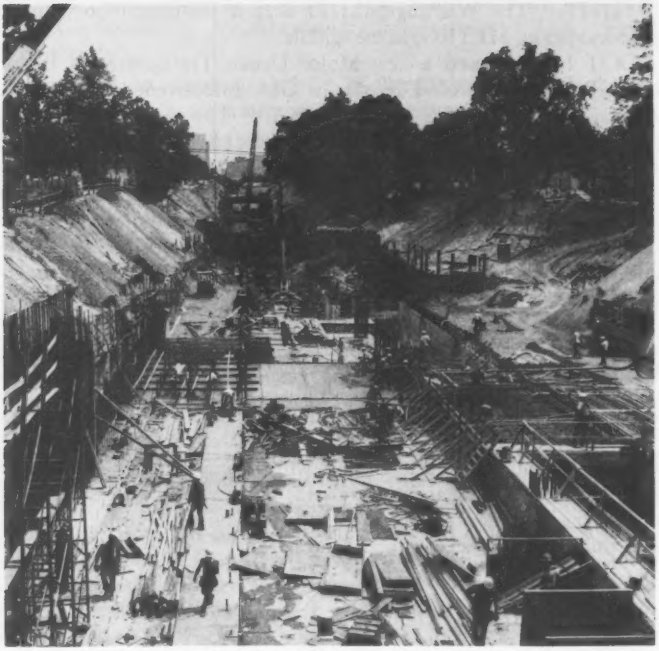
FEDERAL PARKING POLICY

In line with current national policies of fostering energy conservation, reliance on public transportation, and improved air quality, President Carter announced in April 1979 that subsidized parking for federal employees would be phased out.

In the downtown area of the District of Columbia (D.C.), more than 30 percent of the executive branch's parking spaces were used in 1979 by single-occupant vehicles, despite a policy goal of reducing this figure to 10 percent.[111] In the suburbs, more than 80 percent of federal employees drive to work alone. In D.C. and nearby Virginia, about 42 percent of all federal employees used federal parking places and thus received a subsidy for a part of the cost of their trip to work. The other 58 percent, who took transit or park in commercial places, received no such subsidy.

The Office of Management and Budget (OMB) announced that for 120,000 to 130,000 federal parking places, 20 to 25 percent of which are in the Washington, D.C. area, the federal government will now charge a fee based on the fair monthly rental value of a parking place. The only exception is in areas where the rental value is less than $10 per month. Agency managers at locations continuing to provide parking without charge will have to set up a plan to encourage carpooling for federal employees and other building tenants.

The pricing policy will primarily affect federal facilities in downtown locations and densely populated suburban areas. However, the new policy should benefit all urban areas because of additional reve-



A portion of the new Atlanta, Ga., rapid transit system—shown here under construction—opened in 1979.

nues, petroleum conservation, less traffic congestion, more transit use, more carpooling, and less air pollution.

REVIEW OF HIGHWAY DECISIONS

During the past year, several controversial interstate highways were approved by Secretary Adams. In each case, efforts were made by federal, state, and local officials to modify the plans to reduce adverse environmental impacts.

Secretary Adams approved I–90 in Seattle in September 1978, despite the highway's challenge for many years by a citizens' group that had recommended using the several hundred million dollars that it would cost to build the highway for public transportation. DOT required the 6.9 mile segment to include six lanes for automobiles and two lanes exclusively for buses and carpools. The highway design also includes a deck over parts of the highway near a park; extensive landscaping; bicycle and pedestrian trails; a 180-acre greenbelt to compensate for a small amount of parkland demolished by the highway; and protection of four historic sites. DOT also required state and local officials to ensure that transit lanes and vehicles would have adequate access to downtown Seattle.

The Secretary and state highway officials reached agreement on I–10 in Phoenix in October 1978. They committed themselves to further study of three archeological sites and partial route realignments; use of a deck to cover the highway near a residential area; exclusive bus and carpool lanes and a program to encourage their use; noise mitigation, such as a ban on heavy trucks and soundproofing of schools and other public buildings; and further study of the interchanges to try to mitigate adverse effects on the surrounding homes.

In April 1979 I–93 in New Hampshire's Franconia Notch State Park was approved, ending a long-standing controversy involving litigation, special legislation, and mediation of the final highway design. The Franconia Notch area includes a sensitive geological landmark known as "The Old Man of the Mountain," which would have been threatened by the earlier proposal for a four-lane highway. In 1971, DOT said that the usual interstate width and design were unacceptable. In 1973, the Congress authorized DOT to consider less than the usual interstate design standards.[112] Congressman James Cleveland of New Hampshire took the initiative in mediating an agreement that would be acceptable to environmental groups and the transportation agencies. The resolution includes a plan for a two-lane highway in the park's most sensitive areas. CEQ has recommended to DOT that Colorado's I–70 in Glenwood Canyon (near Glenwood Springs) follow a similar design.

The Century Freeway (I–105) in Los Angeles County was approved in October 1978. The most controversial issue was the relocation of several thousand people whose homes were being taken for the highway right-of-way. The final agreement includes strict relocation standards to assist those individuals in finding adequate housing elsewhere. DOT's approval also provides for exclusive bus and carpool lanes, depressed grades near residential areas, noise barriers, soundproofing of schools, and a new plan to encourage more bus and carpool ridership. The state will also purchase adjacent land for buffer zones and will relocate some of the houses to other neighborhoods in the county.

WITHDRAWAL OF HIGHWAY PROJECTS

A number of localities took advantage of the 1973 "Interstate Transfer" provision that allows local officials, with the concurrence of their governor, to withdraw a proposed interstate highway and use the funds for other transportation projects, including transit.

Governor Hugh Carey of New York requested the withdrawal of two segments: I–687, near Albany, and I–495 on Long Island. DOT approved the first request in July 1978 and the second in June 1979. The I–687 withdrawal will free $52 million for other projects; the I–495 withdrawal will provide $260 million. The funds are expected to be used for a wide range of projects, from bridge and road maintenance to better bus service.

Former Mayor Walter Washington of the District of Columbia received approval in September 1978 for the withdrawal of I–295 and I–395. Together they are worth about $60 million; these funds will be used for METRO (the area's subway system) and for bridge and road maintenance.

INTERCITY RAIL

Most intercity rail passenger service since 1971 has been operated by the National Rail Passenger Corporation (Amtrak). From fiscal year 1972 (its first full year of operation) to fiscal year 1978, the deficit from that operation has more than tripled from $153 million to $578 million.[113] Disturbed by this trend, Congress called for a re-examination of the Amtrak system. The Amtrak Improvement Act of 1978 directed the Secretary of Transportation, in cooperation with Amtrak, to develop recommendations for an Amtrak route system ". . . which will provide an optimal intercity railroad passenger system, based upon current and future market and population requirements, including where appropriate portions of the Corporation's existing route system." [114]

As specified in the legislation, the first phase of the route re-examination began in May 1978 when DOT published "A Preliminary Report to Congress and the Public: A Reexamination of the Amtrak Route Structure."

Between May 1 and August 31, 1978, the Rail Services Planning Office (RSPO) of the Interstate Commerce Commission held hearings in 51 cities. Public opinion, as expressed in the hearings, was sharply divided about the proposed rail cutbacks.

On January 31, 1979, after considering the views of the RSPO, the public, and the potential environmental impacts, DOT submitted its final report of recommendations to Congress and the public.

The recommended route structure serves 22 of the nation's 25 largest population centers, 39 of the largest 50 cities, and 40 states. It provides a basic national service grid, with east/west routes in the northern, central, and southern regions of the country and north/south routes along the Eastern Seaboard, in the Midwest, and on the west coast. The national service grid is supplemented by a system of short-distance trains linking major population centers and feeding passengers into the national service grid. All currently operating state-supported services (governed by Section 403(b) of the Rail Passenger Service Act of 1970) are included in the recommended route system, provided there is continued state support for them.

The recommended route structure contains 43 percent fewer route-miles than the current Amtrak system (including the Southern Crescent). During fiscal year 1980, Amtrak trains will run 34 percent fewer train-miles than the current system would have in that year. However, the recommended system will retain approximately 80 percent of the passenger-miles included in the current system and will serve 91 percent of the passengers who would have used the system

during that year. The recommended system will seek to upgrade its current average of 32 passenger-miles per train-mile, reflecting the elimination of the very weak routes and the restructuring of other routes.

DOT has argued that the increase in the use of each Amtrak train will save energy compared to the current Amtrak system, as a result of the increased ridership and more intensive use of each train. Second, the federal subsidy required for the recommended system will be nearly $1.4 billion less than would be required for the current system during the next 5 years.

Ironically, however, as this report went to press, ridership in many of the routes affected by cuts was growing almost daily as a result of uncertainties about gasoline availability. The Amtrak Improvement Act of 1978 provided that the recommendations in the final report would automatically be adopted unless, within 90 calendar days of continuous session, either House of Congress adopts a resolution of disapproval. Implementation must be completed within 1 year of the adoption of the recommendations. With certain limited exceptions, however, the route system itself cannot be modified or restructured prior to October 1, 1979.

AIRPORTS

In April, Secretary Adams sent to the Congress a proposed $6.6 billion, 5-year bill for airport development and for the purchase of radar and other airway electronics equipment.[115] The bill includes programs for noise reduction, such as:

- Land purchases for noise buffer zones;
- Soundproofing of schools and hospitals;
- Grants for noise monitoring equipment;
- Establishment of a single method for measuring noise impacts; and
- Grants to prepare noise abatement plans.

During the past year, the Federal Aviation Administration (FAA) has provided grants to several dozen communities to prepare plans to reduce noise and to encourage compatible land uses around airports. FAA's noise abatement program carries out DOT's 1976 "Aviation Noise Abatement Policy Statement."

In October 1978, Congress passed the Airline Deregulation Act.[116] One of the purposes of the legislation is to preserve a competitive environment in commercial aviation, including flexibility of carriers to enter new markets. However, some airports attempted to control noise by restricting entry of new carriers. In addition to doing little to control noise, these restrictions undermine competition, thus conflicting with the purposes of the deregulation legislation.

For airports subject to unacceptable levels of noise, a program of noise allocation was developed by the Civil Aeronautics Board in cooperation with the FAA.[117] This approach provides a flexible means of achieving noise goals without discouraging competition.

The airport can calculate a noise share or allocation for each airport user, based on its numbers, times, types of operations, and flight procedures. Each user's allocation could be transferable to other users. A carrier using all of its allocation could add flights by using quieter aircraft. Some portion of the noise rights could be reserved for new entrants to the airport, or a fraction of each allocation could expire periodically and be available for reallocation. Another means to allocate noise would be to set landing fees on noise levels.

FAA has worked to insure compatible land use around airports. For example, the sponsor of a new general aviation airport at Albuquerque, N.M., acquired more than 5,000 acres of land as an airport buffer zone. The sponsor agreed to develop an acceptable land use plan for the areas around the airport affected by noise.

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117. Letter from Philip J. Bakes, Jr., General Counsel, Civil Aeronautics Board to Viggo Butler, Burbank-Glendale-Pasadena Airport Authority, California, May 24, 1979.

CHAPTER 9

NOISE

I have wished a bird would fly away,
And not sing by my house all day;

Have clapped my hands at him from the door
When it seemed as if I could bear no more.

The fault must partly have been in me
The bird was not to blame for his key.

And of course there must be something wrong
In wanting to silence any song.

Robert Frost

In rural New England in 1928, Robert Frost found his concentration interrupted by one of nature's lesser creatures. Today this same setting might well include the noise of a power saw, jet airplane, or snowmobile. Most of us would agree with Frost that the song of a bird is part of the natural order of things, even if it occasionally annoys. The same cannot be said of the noise of modern, technological society, which can degrade the environment and the quality of our lives.

Noise and quiet are relative terms. The physical intensity of sound is measured objectively in decibels, but "noise"—unwanted sound—is also defined by subjective factors, such as setting and sources. To the poet or naturalist, for instance, quiet may mean the solitude of the wilderness, where the natural world lies undisturbed. To the urban dweller it may be relief from the perpetual barrage of city noises to be found in an apartment, home, or workplace, where noise from traffic, construction, industry, or aircraft cannot penetrate.

Noise is acceptable at certain times, within certain bounds, and at appropriate levels. Depending on the setting and source, even a loud sound, such as the roar of Niagara Falls, may be pleasurable. Noise at tolerable levels is an integral part of every vibrant city; the activities that contribute to the health of the city also generally produce noise. But in the past several decades, urban noise levels have increased at a dramatic rate and are contributing to urban decay.

Nearly half the U.S. population is regularly exposed to levels of noise that interfere with such normal activities as speaking, listening, and sleeping. Many people are subjected to high levels of noise in their homes or at work. The suburbs near urban centers are beginning to experience levels of traffic and industrial noise once confined to the cities. And even deep in the country's parks and forests, quiet is often shattered by the noise of motorcycles and airplanes.

Noise is primarily an urban problem, however. According to a recent Gallup poll, urban residents consider quiet one of the most important qualities in an ideal neighborhood, along with friendly people, good housing, and low crime rates. Quiet placed ahead of cleanliness, good schools, nearby shopping, and low traffic on the list of qualities respondents valued.[1]

The annual Bureau of the Census survey, conducted for the U.S. Department of Housing and Urban Development (HUD), has found in recent years that noise is the most frequently mentioned undesirable neighborhood condition in central cities (see Figure 9–1). Every year of the survey, approximately one-half of the respondents identified noise as an undesirable condition in residential neighborhoods. Also, noise was one of the two leading reasons given by people who wanted to move from their neighborhoods because of undesirable conditions; the other was crime. In the 1976 survey, noise was mentioned as an undesirable feature of the neighborhood three times as often as crime.[2]

Noise is a major environmental factor adversely affecting the quality of people's lives. More than that, noise is also a health problem. The next section explains the biomedical effects of noise, followed by a discussion of the nature and growth of noise sources in America, and what can be done—and is being done—by municipalities and states to control noise, as well as the federal role in assisting them. The chapter ends with a critique of the present national noise abatement effort and how it could be improved.

HEALTH AND WELFARE EFFECTS

HEARING LOSS

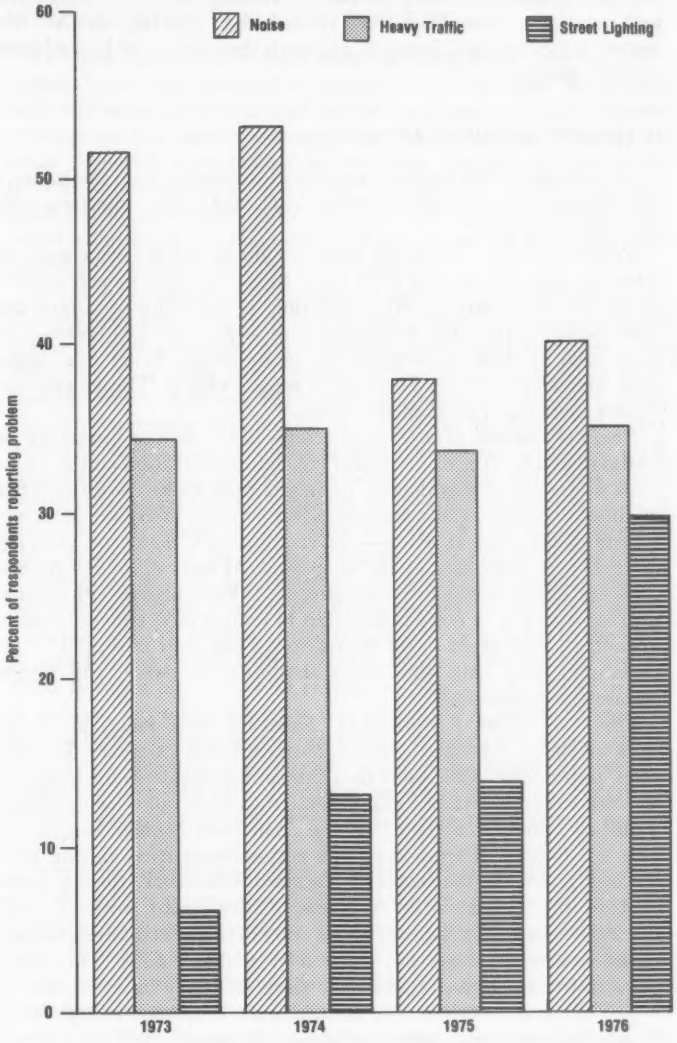
Perhaps the most serious consequence of noise exposure is its effect on hearing. Because the number of high-level noise sources has increased sharply in recent years, potentially harmful levels of noise are found in many cities and urban areas. It is estimated that as many as 20 to 25 million people—about 1 in 10 in the United States—are exposed to noises of duration and intensity sufficient to cause a permanent reduction in their ability to hear.[3] Of these, 10 to 15 million are estimated to be workers exposed to excessive noise on the job.[4] These include agricultural workers, construction workers, mine workers, and truck drivers, as well as factory workers.

Hearing loss due to noise exposure usually occurs gradually so that considerable deterioration may occur before one is aware of the

Figure 9–1

Undesirable Neighborhood Conditions in the United States, 1973–76

(sample size 69,337–74,005)



Source: U.S. Department of Housing and Urban Development Annual Housing Survey, 1973–1976.

damage. The damage is irreversible. When the highly specialized cells needed for hearing are destroyed by excessive exposure to noise, they do not regenerate and cannot be repaired.[5] If hearing continues to deteriorate, it becomes a handicap for which there is no cure.[6]

Hearing loss has a profound effect on the victim's life by interfering with speech, distorting sounds, preventing use of the telephone, and creating a depressing sense of isolation.[7] Hearing aids do not restore noise-damaged hearing, although they can be of limited help to some people.

INTERFERENCE WITH ACTIVITIES

An estimated 102 million Americans—virtually half the nation's population—are exposed to noise levels that may interfere with everyday activities.[8]

Noise and Sleep Noise can make it difficult to fall asleep, and can interrupt sleep by causing shifts from deeper to lighter sleep stages.[9] Although the apparent effects may only be a feeling of fatigue the next morning, repeated interruption of sleep over long periods of time, such as those experienced by many people living near highways and airports, may have more serious effects. The elderly are usually more easily awakened by noise.[10]

Communications Interference Noise is an obvious hindrance to communication. It is of particular concern in education and in situations where safety may depend on hearing the spoken word or other auditory warning signals. But the effect of noise interference on the quality of activities at home—conversations, TV watching, reading, or other activities—should not be ignored. At least 40 million Americans—or nearly one in five—are affected.[11] Even people with normal hearing who live in noisy places tend to reduce their communication with others and avoid social interaction. They tend to simplify their communications, talk only when absolutely necessary, and repeat themselves frequently.[12]

Effects on Work Performance Excessive noise seems to hinder work efficiency even when communication is not necessary. In some cases, particularly when close concentration is required, the accuracy of work suffers.[13] Studies also suggest that high noise levels during a task contribute to fatigue.[14] If the home itself is noisy, the worker may not find relief from the day's accumulated stress during nonworking hours. In the words of Leonard Woodcock, former president of the United Auto Workers, "They (auto workers) find themselves unusually fatigued at the end of the day compared to their fellow workers who are not exposed to as much noise. They complain of headaches and inability to sleep and they suffer from anxiety. Our members tell us that the continuous exposure to high levels of noise makes them tense, irritable, and upset." [15]

A 1977 Quality of Employment survey by the U.S. Department of Labor showed that 30 percent of the 2,300 workers surveyed in all types of employment considered noise in the workplace a problem of

some degree. Of those reporting the problem, 20 percent of the workers said that excessive noise was a major problem, another 20 percent said it was a sizable problem, and 50 percent said it was a slight problem.[16]

NOISE AND STRESS-RELATED PROBLEMS

The idea that people become totally accustomed to noise is a myth. Although we may get used to constant low-level noise, the human body will make automatic and unconscious responses when exposed to either sudden sounds or loud sounds.[17] Noise creates physiological stress. Although most noise does not mean danger, our bodies still react as if these sounds were a threat or a warning. In effect, the body involuntarily shifts gears. Adrenaline is released. Blood pressure rises, and muscles tense.[18] If the noise is sudden, it does not even have to be particularly loud for these reactions to occur.

Growing evidence strongly suggests a link between noise and cardiovascular problems, especially hypertension. Because noise is only one of several environmental causes of stress, researchers cannot say with confidence that noise alone causes the heart and circulatory problems they have observed. What they can point to, however, is a statistical relationship apparent in a number of field and laboratory studies. Epidemiological studies, which have attempted to take other factors into account, indicate that workers in noisy industries have a significantly higher rate of cardiovascular problems than those in quiet industries.[19] It could be that other factors, such as higher levels of toxic substances in the noisier factories, contributed to the higher disease rates. But the studies strongly suggest that at least an association with noise exists. Further research is necessary on this relationship.

In one research project, rhesus monkeys were exposed to the kinds of noises heard by the typical factory worker. The animals' systolic blood pressure jumped by 43 percent during 3 weeks,[20] and tended to remain high when the noise was shut off.[21] A similar increase in human blood pressure would mark the difference between a normal person and one with hypertension. Some of the noises the monkeys listened to each day were the ring of an alarm clock, the buzz of an electric razor, street traffic noise, and 8-hour recordings of factory noise.[22]

It may be that the generalized stress response to noise is also responsible for effects on reproduction. Before birth, the developing child is responsive to sounds in the mother's environment. Particularly loud noises have been shown to stimulate the fetus directly, causing changes in the heart rate.[23] Although definitive cause and effect relationships have not been established, studies of babies born to women living in noisy areas have shown evidence of a significantly higher incidence of low birth weight.[24] Such low birth weights are a statistically reliable indicator of increased susceptibility to many serious health problems for the newborn.[25]

Noise-related stress is associated with emotional problems as well as physiological symptoms. Noise can trigger extreme behavior, as stories in newspaper files and police records indicate. For example, a man shot a boy who refused to stop making noise outside his apartment.[26] Repairmen have been threatened with guns [27] and motorboat operators shot at [28]—all because of the noise they were making. Noise can also inhibit or reduce helping or cooperative behavior. For example, in an outdoor study, a person with an arm in a cast dropped an armload of books while walking past a lawnmower. People were considerably less likely to stop and help pick up the books when the lawnmower was running.[29]

EFFECTS ON CHILDREN

The effects of noise on children are a matter of longstanding concern. The effects discussed so far could be still more serious if they interfere with normal childhood development. No one knows for sure whether children are particularly susceptible to noise-induced hearing loss, but there are indications that hearing loss among children is increasing.[30] Among the more serious recent findings is the preliminary conclusion that grade school children exposed to aircraft noise in school and at home had higher blood pressures than children in quieter areas. The exact implications for their health are not known, but certainly this finding is cause for serious concern.[31]

In addition, there are effects of noise on learning to consider. In the early 1900s, "quiet zones" were established around many of the nation's schools to reduce noises believed to interfere with children's learning. Today, researchers have rediscovered that learning difficulties are likely byproducts of noisy schools, play areas, and homes. Because they are just beginning to learn, children have more difficulty understanding language in the presence of noise than do adults. If children have to speak and listen in a noisy environment, they may have difficulty developing an essential skill such as distinguishing the sounds of speech.[32]

Reading ability also may be seriously impaired by noise. A study of reading scores of 54 children in grades two through five indicated that the influence of noise in the home was a more significant factor affecting reading performance than the grades the youngsters were in, the parents' educational background, or the number of children in the family. The longer the children had lived in a noisy environment, the more pronounced the reading impairment.[33]

Noise in the school can also have a detrimental effect. In a school located next to an elevated railway, students whose classrooms faced the tracks scored significantly lower on reading tests than did similar students whose classrooms were farther away.[34] In Inglewood, Calif., the effects of aircraft noise on learning were so severe that several new schools had to be built in quieter locations. As a school official explained, the disruption of learning went beyond the time wasted waiting for noisy aircraft to pass over. Considerable time had to be

spent after each fly over refocusing students' attention on what was being done before the interruption.[35]

NOISE SOURCES AND TRENDS

NOISE SOURCES

In the past 2 decades there has been a dramatic increase in the number of noise sources. There are more cars, trucks, motorcycles, and other vehicles on our highways than ever before. There are more office typewriters, more houses equipped with air conditioners and noise producing "labor-savers," and more industrial plants. One finding of the Urban Noise Survey, conducted by the U.S. Environmental Protection Agency (EPA) in 1976, is that no single noise stands out

SOME WAYS TO MEASURE NOISE

Instantaneous Measurement Sound is measured in decibels (dB). However, sounds of the same intensity (level) can differ in the frequencies of which they are composed. Sound level meters have several scales that electronically filter high and low frequencies in slightly different ways to produce single-number measures of the overall level at a given instant. The "A scale" is most often used to measure environmental noise. Its filtering (weighting) causes it to respond to sounds in much the same way as the human ear responds. All sound levels in this chapter are A-weighted.

Equivalent Sound Level (L_{eq}) Because many sounds fluctuate from moment to moment, it is desirable to have some kind of average level to describe the noise environment. L_{eq} is an energy average of sound levels during a given period of time. It is not the same as an arithmetic average because "peak" levels contain much more energy than the corresponding "valley" levels. Thus, in Figure 9–2, the L_{eq} is about 58 dB.

The major virtue of L_{eq} is that it correlates reasonably well with the effects of noise on people, except when the time of occurrence (day or night) is relevant.

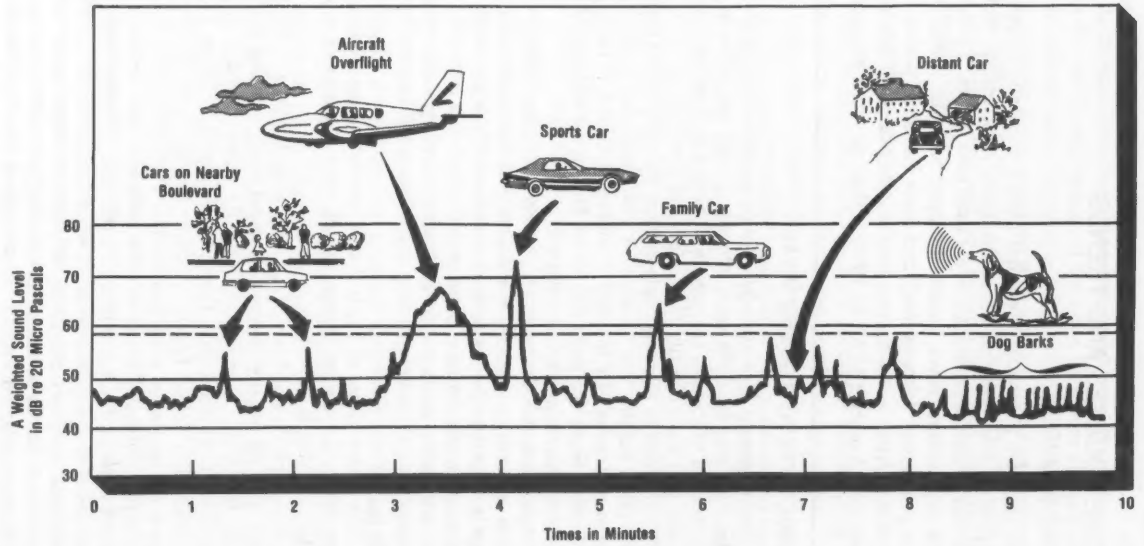
Day-Night Sound Level (L_{dn}) L_{dn} is an L_{eq} for a 24-hour period with a 10 dB penalty imposed on sound levels occuring at night (10 p.m. to 7 a.m). A typical use is for the characterization of noise in residential neighborhoods. Examples are shown in Figure 9–3.

Maximum Sound Levels Another frequently encountered measure is the maximum noise produced by a particular noise source. For example, regulatory limits on noise emissions from products are frequently specified in terms of some maximum allowable noise level, as measured at a standard distance, while the product is operated in a way that produces maximum or near-maximum noise. Obviously such levels cannot be compared meaningfully with L_{eq} or L_{dn} values.

Source: Adapted From *Protective Noise Levels,* EPA 550/9–79–100, November 1978, pp. 4–9.

Figure 9–2

Typical Outdoor Sound Measured on a Quiet Suburban Street



Source: U.S. Environmental Protection Agency, *Protective Noise Levels*, EPA 550/9-79-100, November 1978.

LEVELS IDENTIFIED TO PROTECT AGAINST EFFECTS OF NOISE

EPA has identified noise levels, which, if not exceeded, should protect against some of the worst effects of noise.[36] They include:

To protect against hearing loss:	L_{eq}(24 hours) = 70dB or less (equivalent to L_{eq}(8 hours) = 75dB)
To protect against activity interference and annoyance:	L_{dn} = 55 dB or less, outdoors L_{dn} = 45 dB or less, indoors

The L_{dn} levels specified are yearly average values. These levels include a margin of safety and were derived, as directed by Congress, without considering the technical or economic feasibility of achieving them. Therefore, they should not be viewed as EPA-recommended regulatory goals, but rather as long-range environmental goals.

in people's minds. In areas not directly exposed to freeway or aircraft noise, most people think of community noise as a general din, made up of many sources rather than one or two. But of the noise sources cited by those surveyed, vehicle noise sources ranked highest, particularly motorcycles, large trucks, and cars. Table 9–1 ranks noise sources for areas with different population densities.

Although certain noise sources are perceived as more annoying than others, it is the combination and total number of sources that determine a community's noise levels. Figure 9–3 gives examples of sound levels that are roughly typical for different locations. It also shows the tremendous range of sound intensities that are compressed into the logarithmic decibel scale. Every 10 dB increase represents a tenfold increase in physical intensity[37] and approximately a doubling in loudness as perceived by people.[38]

Outdoor noise levels are a function of population density. In the medium and large cities of the nation, with populations greater than 100,000 and/or population density greater than 2,500 persons per square mile, noise is definitely of increasing public concern. Objective measures confirm that noise levels are generally higher in cities with greater population densities.

Figure 9–4 shows a mathematical (regression) line constructed from a large number of studies showing the typical correlation between outdoor noise level and population density. The scatter shows that it is not possible to predict accurately the noise levels for a particular area from the population density alone. But for a large number of areas, or the entire urban United States, it is possible to use the regression formula to estimate statistically the various local levels of noise.

Since 1970, population growth in rural counties has surpassed that of urban areas. However, the absolute numbers of people living in metropolitan areas have continued to increase.[39]

Table 9–1

Noise Sources Considered "Highly Annoying"

(In areas away from the direct impact of freeway or aircraft noise)

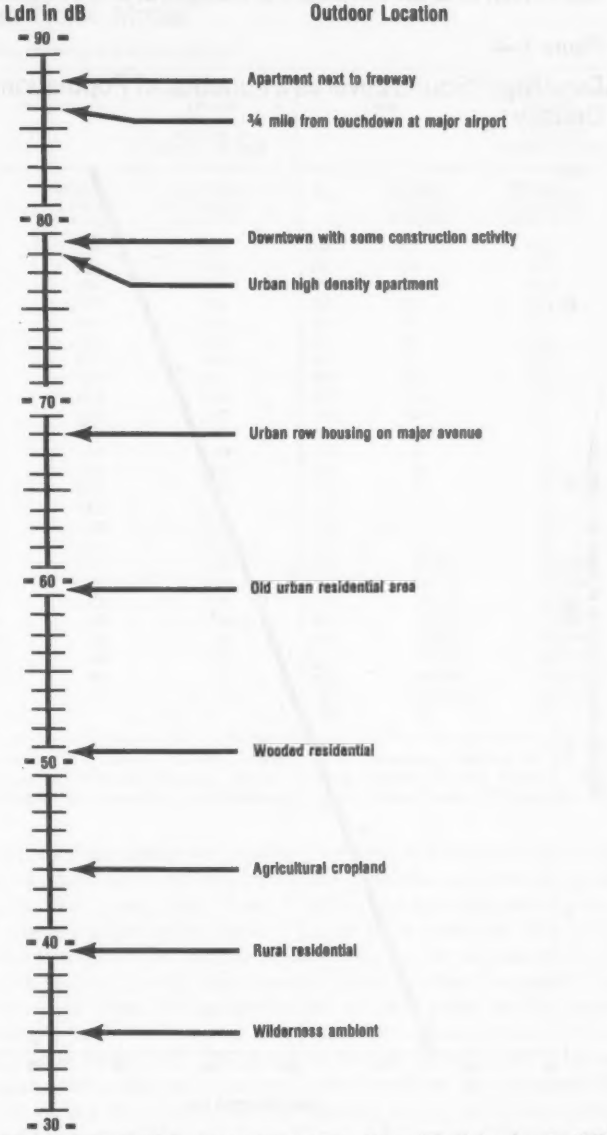
$p \leq 3{,}000$ (37%)			$3{,}000 < p < 20{,}000$ (51%)			$p \geq 20{,}000$ (12%)		
Rank	Source	%H.A.	Rank	Source	%H.A.	Rank	Source	%H.A.
1	Motorcycles	9.4	1	Motorcycles	13.2	1	Motorcycles	12.7
2	Helicopters	5.3	2	Large trucks	10.0	2	Autos	9.4
3	Autos	4.2	3	Autos	7.4	3	Large trucks	7.3
4	Construction	3.7	4	Construction	7.2	4	Construction	6.5
5	Airplanes	3.2	5	Sport cars	7.0	5	Sport cars	5.9
6	Sport cars	3.1	6	Constant traffic	5.5	6	Constant traffic	4.7
7	Large trucks	2.6	7	Small trucks	4.1	7	Buses	4.7
8	Power garden tools	1.8	8	Buses	3.5	8	Small trucks	4.1
9	Small trucks	1.5	9	Airplanes	3.4	9	Helicopters	3.9
10	Constant traffic	1.5	10	Helicopters	3.1	10	Airplanes	3.6
11	Buses	1.1	11	Power garden tools	2.1	11	Power garden tools	1.2
		55.9			62.2			66.0

p = population density in people per square mile.
% H.A. = percent of respondents highly annoyed by source.
Rank = rank order of noise sources that highly annoy respondents.

Source: U.S. Environmental Protection Agency, *The Urban Noise Survey* (Washington, D.C.: U.S. Government Printing Office, August 1977), p. 38.

Figure 9–3

Examples of Outdoor Day-Night Average Sound Levels in dB Measured at Various Locations

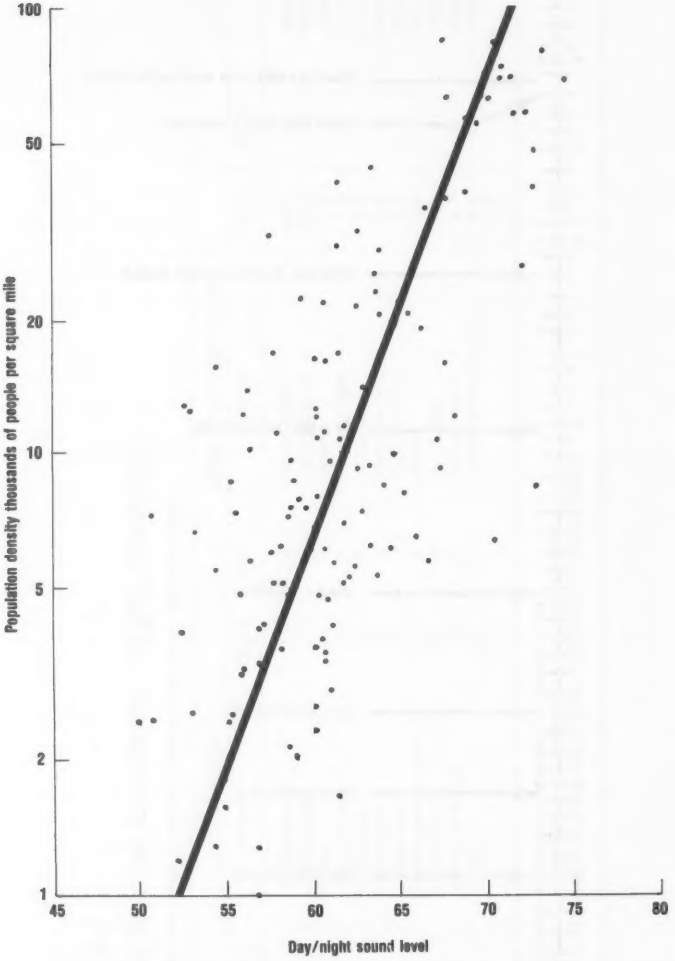


Source: U.S. Environmental Protection Agency, *Protective Noise Levels*, EPA 550/9–79–100, November 1978.

Table 9–2, based on 1970 population densities in urban areas, provides estimates of the numbers of people exposed to various levels of outdoor noise; the estimates are conservative because freeway and aircraft noise are excluded. For example, at least 93 million peo-

Figure 9–4

Day/Night Sound Level as a Function of Population Density



Source: U.S. Environmental Protection Agency, *Population Distribution of the United States as a Function of Outdoor Noise Levels*, June 1974, p. 15.

Table 9–2

Estimated Exposure of U.S. Population to Various Levels of Environmental Noise According to the Urban Noise Model

(excluding freeway and airport noise)

	Urban Only	Total Estimate (Rural Estimate Added to Urban Model)		Urban Only	Total Estimate (Rural Estimate Added to Urban Model)
L_{dn}	Millions of people exposed	Millions of people exposed	L_{dn}	Millions of people exposed	Millions of people exposed
34	134	180	59	67	67
35	134	179	60	59	59
36	134	177	61	51	51
37	133	174	62	44	44
38	133	170	63	37	37
39	132	168	64	30	30
40	131	165	65	24	24
41	130	161	66	19	19
42	129	158	67	15	15
43	128	153	68	12	12
44	126	150	69	9	9
45	124	149	70	7	7
46	122	145	71	5	5
47	120	140	72	4	4
48	118	135	73	3	3
49	116	130	74	2	2
50	113	123	75	1	1
51	110	118	76	0.889	0.889
52	107	112	77	0.559	0.559
53	103	108	78	0.332	0.332
54	99	100	79	0.187	0.187
55	93	94	80	0.093	0.093
56	88	88	81	0.039	0.039
57	81	81	82	0.012	0.012
58	74	74	83	0.002	0.002
			84	0	0

Source: W. J. Galloway, K. Mck. Eldred, M. A. Simpson, prepared for the U.S. Environmental Protection Agency, Office of Noise Abatement and Control, *Population Distribution of the U.S. as a Function of Outdoor Noise Levels*, 1974, pp. 25, 28.

ple—all in urban areas—are regularly exposed to outdoor noise levels of L_{dn} of 55 or more. At least 59 million people are exposed to levels of L_{dn} of 60 or more, and at least 7 million live in an urban environment where outdoor noise levels of L_{dn} of 70 or more are the rule.[40]

Table 9–3 shows the number of people exposed to various levels of noise (including aircraft and freeway noise) in the community, by the source of noise. Urban traffic and aircraft noise are the overwhelmingly important sources of all community noise levels for L_{dn} levels greater than 60 dB. The situation in other industrialized nations is similar, with traffic noise an even worse problem. An estimated 40 percent of the U.S. population is exposed to L_{dn} of 55 or more, versus 22 percent in Norway, 50 to 70 percent in most of Europe, and 80 percent in Japan. But aircraft noise is relatively worse in the

Table 9–3

Number of People in the Community Exposed to Various Levels of Noise by Noise Source

(number of people in millions for each noise category)

L_{dn} (dB)	Urban Traffic	Rural Traffic	Air-craft	Rail	Agri-cultural	From Industrial Sites	Home Appli-ances
80	0.4		0.3				
75	2.0		0.8				
70	7.1	0.2	2.5				
65	21.6	1.0	7.9	0.4			
60	54.1	2.8	19.9	1.1		1.6	
55	102.1	4.8	50.0	2.4	0.1	6.3	15.0

Source: Bolt, Beranek, and Newman, Inc., prepared for U.S. Environmental Protection Agency, Office of Noise Abatement and Control, *Noise in America* (Washington, D.C., 1978), p. 45, C–17.

United States: 13 percent of the population is exposed to L_{dn} levels greater than 55, whereas only 3 percent is exposed to those levels in Japan and Europe.[41]

As previously mentioned, an estimated 15 million Americans regularly work in potentially hazardous noisy environments. Many of these workers are becoming increasingly concerned about the health risks of working in such noisy conditions. According to an insurance industry study, noise-induced hearing loss is the occupational health hazard that affects most workers and for which financial compensation claims are greatest—nearly $200 million since 1969 for federal employees alone.[42]

TRENDS

Compensation Payments for Work-Related Hearing Loss The number of compensation payments has been escalating, especially in those industries with the noisiest machinery.[43] Although union activity and heightened worker awareness have partly influenced this trend, the claims do not yet reflect the extent of the problem. The amount of compensation that can be awarded to workers for hearing loss varies considerably depending on the state,[44] but the size of the claims is generally increasing.[45]

The number of annual hearing loss claims from federal workers alone rose from 200 in 1966 to more than 8,000 by 1975.[46] In 1977, there were more than 6,000 claims at the state level, resulting in awards of approximately $13 million. At the federal level there were approximately 2,300 claims amounting to awards of $17.6 million.[47] Most of these claims, however, are not fully compensated due to restrictive filing criteria.[48] The response of states to these claims varies considerably. Only nine states compensate almost all of the nonfederal hearing loss claims.[49] The prospect is that the number of claims and amount of awards will increase rapidly in the next 10 years. The cumulative state and federal benefits paid from 1977 to 1987 could easily

reach $0.8 billion. Given the rapid recent increase in the rate of claims, this estimate seems based on rather conservative assumptions (7 percent annual cost of living increase in benefits; 10 percent annual increase in numbers of claims).[50]

Road Traffic Noise Noise from road traffic is continuing to increase. According to the EPA's Office of Noise Abatement and Control, by the year 2000 noise levels will increase significantly and so will the number of people exposed to these levels. Even now an estimated 13.5 million people in the United States are exposed to an outdoor L_{eq} of 75 dB or greater from transportation or recreation vehicles,[51] a level sufficient to cause risk of permanent damage to hearing.[52] Even after federal noise regulations take effect, overall noise from cars, trucks, buses, and motorcycles will increase over time because of the anticipated increase in the number of vehicles.

According to one projection, the number of automobiles may increase from 84 million in 1977 to 130 million by 1985; and trucks from 17 million to 28 million.[53] Another source estimates that automobiles in use will increase by 0.6 to 0.7 percent each year through the year 2000.[54] Compounding the problem is the fact that the average levels of automobile noise are likely to go up with the increased sales of both 4-cylinder gasoline-engine and diesel-engine automobiles. These engines are noisier than the V–8 gasoline engines, which currently make up more than half the auto market.[55] The number of buses of various types (intercity buses, school buses) also is expected to continue to increase.[56] Various projections may not agree exactly on rate of growth, but they all agree that the number of noise sources is increasing.

Noise Emissions From Aircraft If current regulations controlling noise emissions from aircraft are implemented, and if special takeoff procedures are used, the land area exposed to aircraft noise L_{dn} levels of 65 or greater will decrease from 2,169 to 1,304 square miles by 1985. The number of adversely affected people is expected to decrease from about 6 million to about 3.6 million by the year 2000, although it then may grow again with increasing air traffic.[57] For those affected, aircraft noise will remain a major problem. These conclusions assume moderate growth of the airlines, i.e., a doubling of the number of planes between 1980 and 2000.

Noise From Rail Rapid Transit This is not currently an extensive problem in the United States because most cities do not now have rail transit. But for the ones that do, the noise problem can be serious. In New York City alone, an estimated 500,000 people are exposed to rapid transit noise between 85 and 100 dB inside their homes.[58] By the year 2000, 325 miles of track will be added to the existing 570 miles of rail rapid transit in the United States, and 2,000 new rapid transit cars will be added to the present fleet of 10,000. The new cars and track will be quieter than existing stock. However, many systems will be using existing noisy cars on new track or new cars on old track. In either case, without application of more noise abatement technology, noise levels will remain high.[59]

Six million people are exposed to noise levels of 65 L_{dn} or greater from U.S. airports. New York's La Guardia Airport affects one million of these people.

NOISE CONTROL AT THE LOCAL LEVEL

What can be done to control the widespread and rapidly growing problem of noise? The federal government is issuing regulations to reduce noise emissions from some of the major offenders. But, for the most part, these regulations apply only to new products and only solve part of the problem. The major impetus for successful noise reduction must be initiated and carried through at the local level, where noise problems and solutions are most apparent.

Although noise problems are often complex, many of the issues of greatest concern to the community can be solved through imaginative planning and coordination of existing resources. Communities around the country are employing a variety of measures, including in-use controls, operational restrictions, land use planning, and regulations on newly manufactured products.

SURFACE TRANSPORTATION NOISE

In-use controls apply to existing products already in use, as opposed to controls on newly manufactured products. In one case, the user or

owner is responsible for obeying the regulation; in the other, the manufacturer or seller is responsible. In early 1979, 164 local communities and 10 states had performance or in-use requirements for automobiles. These programs range from enforcement of existing local, state, or federal regulations to stringent local laws that require periodic inspection of vehicles.[60] Chicago, for example, designates two special vehicle enforcement teams to monitor motor vehicle noise from preselected sites around the city. The Department of Environmental Control has approved sites, based on measurement specifications that require a clear area within a 100-foot radius of the noise meter in order to get accurate readings. The biggest enforcement problem is being able to prove that somebody exceeded the noise limit. Improper measurement techniques can result in different readings from the same vehicle at different measurement sites because sound is reflected from buildings or other obstructions. When a violation occurs, the measurement team notifies a police car to apprehend the offender.[61]

Colorado Springs has a particularly vigorous noise control program, which focuses primarily on in-use control of motor vehicles. City patrolmen, certified as noise technicians, work chiefly on noise control, although they are qualified to perform normal police duties. A vigorous enforcement system with stringent penalties for violators, combined with the support of the community, the City Attorney's Office, and the municipal judges has resulted in a highly effective program.[62]

Area and time restrictions have also proven to be effective operational controls. Routing trucks away from residential or high traffic areas is a common measure that also applies to safety and general traffic management.[63] Both Denver and Colorado Springs restrict noisy trucks from traveling in certain areas during night and early morning hours. Chicago does not allow garbage collection at these times.

Land use restrictions and urban planning to reduce noise are proving among the most effective and cost-efficient local alternatives. However, where serious problems already exist, such as heavy traffic noise on a highway adjoining a school or hospital, noise barriers can be constructed. For instance, in Portland, Oreg., noise barriers will be built along a major street to protect nearby residents. In addition, some houses and apartments will be purchased by the city and the residents relocated to quieter areas.[64]

Advance planning for mass transit and road development should include noise control measures. Many cities are designing mall transit systems to provide quick and efficient transportation into and around the city. Buses are the predominant users of these transit malls, which concentrate bus traffic in a single corridor. When the malls are located adjacent to pedestrian malls, or in business or residential areas, high levels of noise exposure often result. Portland, Oreg. was recently faced with such a problem, and is now experimenting with retrofitting of buses to make them quieter.[65] New York City is currently designing a bus/pedestrian mall—the Broadway Plaza

Project—and is incorporating noise control into its plans. The purpose of the project is to clean up the Times Square area and to reduce vehicular noise by rerouting traffic. The bus-boarding areas will be at the edge of the mall, which features shops, restaurants, and theatres.[66]

Local governments may apply noise regulations to a wide range of newly-manufactured products. Chicago has established noise limits on newly-manufactured vehicles, construction and industrial machinery, and some equipment used in residential areas.[67] Although many state and municipal governments are currently regulating the noise levels of new products, EPA is charged with developing uniform national noise emission standards for certain products it determines are harmful to the public health and welfare. EPA is drawing on the data and experiences provided by states and localities in developing the federal regulations. EPA intends these regulations, when they go into force, to preempt all existing state and local noise emission laws that are not identical to the federal standard, which should eliminate the problems manufacturers would otherwise face with an assortment of state or local noise level requirements. State and local governments would not be preempted from imposing additional sale or in-use restrictions on the same products.

AVIATION NOISE

As airports and air traffic continue to increase, the progress made in aviation noise control will ultimately be in danger of being reversed. Aviation noise is a complex and controversial issue involving a variety of jurisdictional responsibilities, regulations, and laws. No easy solutions exist, particularly where airports are already surrounded by hundreds of thousands of people, as the pictures and Table 9–4 illustrate. However, some remedies can be achieved through effective planning and cooperation.

Table 9–4

The 10 U.S. Airports With the Largest Populations Exposed to L_{dn} of 65 or More

Airport	People Exposed to L_{dn} of 65 or More	Airport	People Exposed to L_{dn} of 65 or More
New York—La Guardia	1,057,000	Los Angeles	292,000
Chicago—O'Hare	771,000	Miami	260,000
New York—JFK	507,000	Denver	180,000
Boston—Logan	431,000	Cleveland	128,000
Newark	431,000	San Francisco	124,000

Source: U.S. Department of Transportation, *Aviation Noise Abatement Policy* (Washington, D.C.: U.S. Goverment Printing Office, 1976), p. 20.

The Federal Aviation Administration (FAA) has primary responsibility within the federal government for civil aircraft noise and has established noise emission standards for most types of nonmilitary aircraft ("newly-certificated aircraft"), as listed in greater detail later in this chapter. Despite the standards, aircraft noise will remain a major national problem in the future because of the growth in operations. Because airport noise is also a local problem, it must also be ameliorated through local actions by airport proprietors.

For airports not already located in developed areas, planning to achieve land use compatibility is an option available to local officials for containing excessive aircraft noise within the airport's boundary or in areas with compatible land uses near the airport. For instance, development at an airport can be planned to reduce the effects of future noise growth. The location of runways, terminal buildings, access roads, and other facilities influence the amount and location of future noise sources.

State and local governments and urban planning agencies can plan and control compatible land use activities near airports through zoning, and limiting the number of sewer or water approvals and building permits. Soundproofing schools, hospitals, and other buildings, and requiring insulation of apartments, homes, and public buildings near airports may be feasible alternatives, although they are less effective.[68]

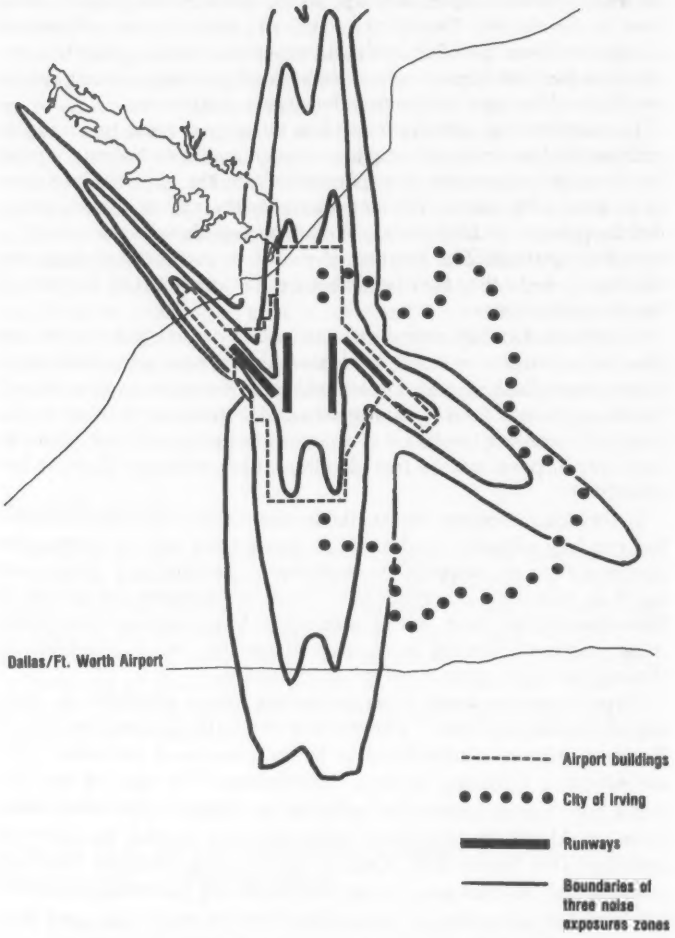
If financial resources are available, the airport and local authorities can buy adjacent land areas to insure their use for compatible purposes such as industrial or recreational development. Buying air rights or easements is another option that compensates the owners of the noise-affected land, but on a one-time basis, without eliminating noise damage.[69] Zoning is another alternative, but it is subject to change due to the pressure of urban expansion.[70]

Airport noise exposure often transcends zoning jurisdictions, causing additional problems.[71] The construction of the Dallas-Fort Worth Regional Airport is considered to be an example of successful land use planning involving multiple jurisdictions.[72] In spite of the airport's huge size and extensive buffer areas, planners determined that there would still be substantial noise exposure beyond the airport's boundary (see Figure 9–5). One of the planning strategies involved rezoning the affected area, which had originally been designated for residential development. A compatible land use study indicated that the land had high potential as an airport-related industrial park, not only because it would be compatible with the adjacent airport, but also because it would provide a higher tax base for the city. As a result of the findings, a new zoning district was written into the city's existing zoning ordinance.[73]

But, as the Dallas-Fort Worth case illustrates, these solutions are never permanent. As the area surrounding the airport is developed and land values increase, pressure builds to develop the area further. For example, the city of Irving, next to the airport, recently rezoned

Figure 9–5

Dallas-Fort Worth Regional Airport and Environs



Source: Adapted from U.S. Department of Transportation, Airport Land Use Compatibility Planning, AC 150/5050-6, 1977, Appendix 4, p. 9.

industrial areas to allow residential construction. Thus noise exposure may become a problem despite initial land use planning.[74]

Dulles International Airport, near Washington, D.C., is an example of what can happen around an airport—even a new airport with plenty of growing room—when there are no strict land use controls or accurate forecasts of projected growth in air traffic. Since 1973, pro-

jections of areas that would be affected eventually by aircraft noise were increased on several occasions.[75] These revisions put additional pressure on the 1972 policy of a nearby county to ban residential development from areas considered "generally unacceptable." The county recently modified its policy to permit new residential construction in an area expected to have noise levels by 1995 ranging from "generally unacceptable" to "intolerable," by HUD and VA standards. The new policy will prohibit residential construction only in the "intolerable" zone. In the other areas, classified as "generally unacceptable," builders will be required to install acoustical insulation in houses and to give buyers a warning.[76]

Airport proprietors have the authority to impose certain operational controls to reduce noise, such as scheduling engine run-ups at times of least annoyance or establishing landing fees based on aircraft noise characteristics or time of day. The proprietor can also make improvements in airport design, land acquisition, and other restrictions on airport use (within appropriate cost, safety, and efficiency limitations). The proprietor may take further measures, such as using preferential takeoff and landing flight tracks that avoid noise-sensitive areas, or requiring that aircraft land farther down runways away from residential areas.[77]

The Huntsville-Madison County Jetport in Alabama is a good example of combining land use and operational controls to contain aircraft noise. Although the airport was built in an open countryside essentially free of noise compatibility problems, expanding urbanization in the area led to the development of a land use plan. Operational controls were designed to keep jet aircraft away from residential areas after takeoff. Controls on new development were also established to encourage commercial and industrial uses of the areas facing heavy exposure.[78]

The Huntsville Jetport is one of approximately 600 airports certified for air carrier operations that transport passengers or cargo on federally approved routes. About 7,000 airports have no air carrier operations and are used only by general aviation traffic.[79] The general aviation airports have fewer FAA restrictions and afford more opportunity for locally initiated noise control measures.

The citizens of Torrance, Calif., encouraged various noise control measures, beginning in 1977, to abate noise from small planes. Noise contours and appropriate data were collected for several years. Data revealed that almost 98 percent of all operations remained below single-event maximum levels of 82 dB at the airport property line. This level was determined to be a reasonable limit for all aircraft operations. Furthermore, the number of operations at the airport's flying school (where student pilots practice takeoffs and landings) was restricted, thereby reducing the number of operations. A curfew with reasonable exemptions was also enacted to limit night flights. In addition, night flights had to meet a more restrictive 76 dB limit at the airport boundary.[80]

Pilots who cannot meet the 82 dB limit are sent notification letters. Most of these pilots have responded and cooperated. Because some pilots had difficulty operating their planes within the specified noise limit, a California court ruled that it would be discriminatory to impose fines for all violations. But when there are violations of the curfew or the restrictions on practice landings, fines may be imposed. Of the 28 pilots cited for violations to date, most were fined an average of $100 plus court costs. With grant assistance from the FAA, the airport is currently conducting a study to quantify the degree of noise control achieved.[81]

OTHER LOCAL GOVERNMENT ACTIVITY

In the past decade the number of local noise control ordinances has increased dramatically. In 1972 only 59 municipalities had some type of noise law. By 1977 that number had grown to 1,067.[82] Today, more than 50 percent of the U.S. municipal population lives in localities having some degree of noise legislation.[83]

Most cities and local governments use a number of tools for noise control, with varying degrees of success. Vehicular noise control, property line standards, building codes, soundproofing, site planning, zoning, public education, and noise abatement planning are several components of effective community noise control programs.

Most prevalent is the property line standard, which is designed to protect people from their neighbors' noise at the property line. These standards are relatively easy to incorporate into a municipal zoning ordinance and are generally effective. They usually apply to nonvehicular noise sources such as power plants, rail yards, factories, construction sites, or air conditioners on commercial or residential property. The majority of property line standards establish a maximum noise level that is enforced at the property boundary of the offending source.[84] They are usually enforced on a complaint basis.

Construction noise is usually regulated by restricting work activity to daytime hours, generally 7 a.m. to 6 p.m. Often specific types of equipment have maximum allowable noise levels, measured from a distance of 50 feet. EPA is proposing standards for several pieces of equipment, such as pavement breakers (or jack hammers) and rock drills,[85] which will alleviate part of the problem, especially if localities help enforce them. A federal standard limiting noise from newly manufactured portable air compressors is already in effect.[86] But source regulations will not be sufficient to contain construction site noise in many cases. Many communities will need to continue to use some form of property line standard and require noise barriers or other measures to control excessive site noise.[87]

Communities seldom use building codes for noise control, although specifications for new construction and renovation of older buildings can significantly reduce noise in the finished buildings.[88] Although the construction industry may be generally knowledgeable in noise control techniques involving building materials, this knowledge does

not always translate into action at the level of the individual worker. Also, most local jurisdictions lack personnel with knowledge of noise measurements and controls to enforce the codes.[89]

Some municipalities are establishing energy requirements for building construction that can have the added benefit of reducing noise. For example, the Housing Insulation Act in California has led to more effective building codes in the state. In San Diego, where a general review of all building plans is required, noise prevention measures have been successfully enforced.[90]

Site planning is another effective tool minimizing noise exposure of a building from some outside source. The amount of cumulative noise in an area is influenced by arrangement of buildings and structures in future development plans; distance from railroads, expressways, and industrial areas; and the type of terrain and vegetation.[91]

Despite the apparent increase in the number of noise control laws, few cities have comprehensive noise laws and even fewer have effective noise control programs. Most local noise ordinances address only a few noise problems and do not consider noise a multisource problem, with each source contributing to the total noise level. For example, there are fewer than 80 cities that have quantitative, comprehensive noise limits regulating land use, motor vehicles, and construction.[92] Most municipal officials consider noise a growing problem in the community, but may underestimate it because they rely heavily on complaints for their perception.[93] Without the support of local elected officials, community residents will not receive the benefits of comprehensive and effective noise control.

Although more cities are establishing noise control programs, there is a severe lack of funding available to implement them. Some of the largest programs, such as New York's and Chicago's, have experienced significant budget reductions.[94]

One effective program, launched and maintained on a modest annual budget of about $0.57 per capita, is the community noise control program in Salt Lake City.[95] After an unsuccessful attempt to institute a program that was too broad and unenforceable, a more specific program was developed that focused primarily on vehicular and property line standards. The city is also assisting seven neighboring communities in noise control efforts.

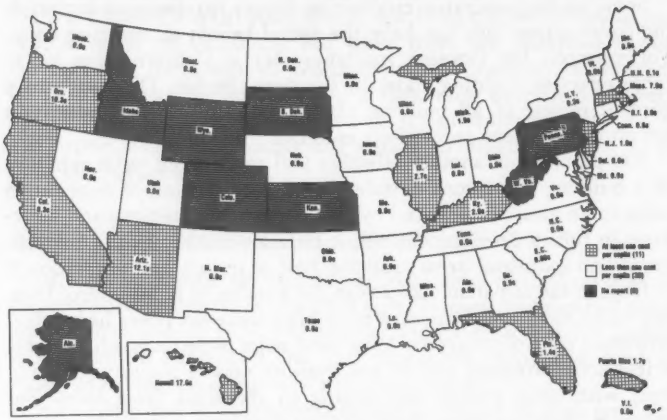
STATE NOISE PROGRAMS

State programs are also underfunded, which generally means that ordinances or other regulations cannot be implemented. In 1977, 27 states had enacted noise legislation, but only 20 states had budgets to support this legislation (see Figure 9–6). Only 11 states were spending more than $0.01 per capita per year on noise control programs.[96]

Furthermore, most of these states have provisions to regulate only one or two categories of noise sources, usually motor vehicles and recreational vehicles (particularly snowmobiles). Only four states—

Figure 9–6

State Noise Expenditures per Capita



Source: U.S. Environmental Protection Agency, *State and Local Noise Control Activities, 1977–1978,* May 1979, p. 4–17.

California, Maryland, Oregon, and Washington—have legislation regulating as many as three or four types of noise sources.[97]

Despite the limited resources available, states are in a unique position to take a leadership role in such matters as providing technical support to localities or establishing statewide regulations. Statewide regulations, such as noise limits for vehicles and land use zones, together with state assistance in implementation, provide localities with the opportunity for low-cost noise control. In California, the State Vehicle Code preempts all local vehicle noise laws and restricts the amount of noise that can be produced by both new and older vehicles. The state enforces noise controls on sales of new vehicles. Enforcement of in-use regulations is shared, with the California Highway Patrol covering state highways and localities covering the other roads. In some cases, such as regulations aimed at faulty muffler and exhaust systems, enforcement requires only an officer's professional judgment that the system has deteriorated. Palo Alto has been enforcing such a law for several years and has experienced a dramatic decrease in the number of noisy vehicles operating in the city.[98]

Illinois used California's experience with statewide vehicle regulations as a model in developing its own standards. The objective of the Illinois program was not only to reduce the general level of road noise but also to control the few vehicles emitting excessive noise. The rulemaking process included four public hearings, detailed studies of noise control alternatives, and cost estimates.[99]

The Illinois law regulates motor vehicles by weight, with an extra allowance for snow tires, so that each type of vehicle is as quiet as

practical. License plate code letters, which are based on gross vehicle weights, assist in enforcement of truck standards. Several other provisions contribute to ordinance enforcement, such as stationary testing at weighing stations and monitoring noise levels from many roadside locations.[100] The Illinois regulations require adequately maintained exhaust systems on all vehicles. Although vehicles with faulty mufflers make up only a small percentage of the total vehicle population, they are the noisiest vehicles on the road.[101]

There is much that states can do for newly-manufactured products, within the framework of federal preemption. Federal noise regulation of newly manufactured products preempts all similar state and local laws. Such uniform national regulation of major noise problems at the source is a key element in the national noise strategy. But state regulations can fill an immediate need in areas where federal involvement is several years away, and they can regulate products not covered by federal standards by demonstrating that certain levels are feasible. Some state action has influenced manufacturers so effectively that federal standards may not be needed. For example, by establishing noise limits on new snowmobiles sold within their boundaries, 14 states helped induce the snowmobile industry to adopt a 78 dB limit for *all* the newly manufactured machines, compared

After 14 states adopted noise limits for snowmobiles, the industry itself set a 78dB limit for all new machines. Several years ago, noise levels from some new snowmobiles went as high as 100dB. Photographer: Cecil W. Stoughton.

with noise levels from these machines as high as 100 dB several years ago.[102]

When federal regulations have already been issued, states are aiding the enforcement process by adopting identical standards and vigorously enforcing them. For instance, all states with in-use truck regulations have adopted the EPA-enacted Interstate Motor Carrier Regulation.[103] Because the U.S. Department of Transportation's (DOT) Federal Bureau of Motor Carrier Safety, which is responsible for enforcing the regulation, has limited resources, states and localities need to help enforce the regulations.

The Federal Aid Highway Act of 1970 requires that noise control be part of the planning and design of all federal-aid highways, or the Federal Highway Administration (FHWA) will not approve highway construction.[104] The 1973 and 1976 amendments to the act allow federal funding of noise abatement along existing highways. FHWA also requires that state highway agencies furnish localities with information on noise and land use.[105]

The construction of noise barriers is the most common noise abatement method used in the highway system today. In Minnesota, more than 50 such projects have already been approved, resulting in more than 20 miles of noise barriers. Funding for the program was initiated by an amendment to the 1975 gas tax legislation providing that 1 percent of the state's annual gas revenues would be spent on noise abatement along the interstate highway system. The federal government provided 90 percent matching funds, for a total of roughly $12 million.[106]

However, it is estimated that it would take thousands of miles of highway barriers to bring noise levels down from the 70 to 75 dB range to the 60 to 65 dB range. Furthermore, the high cost of barriers means that they should not be relied upon as a general cure for highway noise.[107]

The example of Cerritos, Calif., shows how state requirements for land use planning can help communities handle their noise problems. Three major highways are aggravating noise exposure in this rapidly growing suburban Los Angeles community. State law, which requires all communities to include noise control in comprehensive planning, has enabled this community to act forcefully in addressing the problem of highway noise. The local government, backed by strong state and public support, has endorsed stringent noise requirements for new residential construction. Through a permit process, developers are required to incorporate noise control into the architectural design, to use soundproofing construction materials and techniques, and to erect noise barriers.[108]

California has also taken the lead in the area of aviation noise, as the first state with airport noise limits. Regulations adopted under a 1969 law impose limits on total airport noise, and include a variance provision with annual hearings and renewals to insure progress toward eventual compliance.[109]

Illinois is considering a statewide noise regulation that would require airport operators to meet specified day-night average noise levels (L_{dn}) using whatever means necessary. The proposed regulation could have a significant impact on O'Hare International Airport, which might require a night curfew on flights or some form of waiver in order to comply.[110]

Maryland has recently enacted legislation to control airport noise impacts by proposing "noise zones" around its airports that would become more stringent as new, quieter aircraft are introduced. Maryland is the only state that owns its major airport, which gives it wider options in influencing the situation.[111]

Virginia has started to implement statewide land use regulations, including a provision for land use around airports. The state is providing technical assistance and devising methods to achieve compatible land use around existing airports, including Dulles.[112]

THE ROLE OF THE FEDERAL GOVERNMENT

NOISE STANDARDS FOR NEWLY MANUFACTURED PRODUCTS

The Noise Control Act of 1972[113] directs EPA "to promote an environment for all Americans free from noise that jeopardizes their health and welfare." It specifies that EPA shall regulate new products in commerce that are "major sources of noise" and shall establish noise labeling requirements for noisy products and for products designed to reduce noise. In 1978, Congress amended this legislation with the Quiet Communities Act[114] to encourage the development of noise control programs on the community and state level. The amendments provided a necessary link and balance between the federal regulatory program and local noise control activities.

EPA began the rulemaking process by examining transportation and construction noise, the primary concerns of most local communities. The agency studied various products—such as trucks, motorcycles, and jack hammers—and considered a broad range of factors, including the absolute magnitude of the noise emitted in typical environments and whether the product is used in combination with other noisy products. EPA's principal objective was to improve the health and welfare benefits to the public by lowering noise emissions from products identified as major noise sources. This was the central theme of the 1972 Act. Also considered was the available technology and the costs to both the manufacturer and the consumer of reducing the noise levels of these products.

Since 1972, EPA has identified 10 products as major noise sources: medium and heavy trucks, motorcycles, buses, garbage trucks, wheel and crawler tractors (used in construction), portable air compressors, pavement breakers (or jack hammers), rock drills, power lawnmowers, and truck refrigeration units (see Table 9–5).

Table 9–5

Federal EPA Product Regulations (Noise Emission Limits on Newly Manufactured Products)

	1976	1977	1978	1979	1980	1981	1982	1983
Portable air compressors	F		E	E				
Medium and heavy trucks	F		E				S	
Wheel and crawler tractors		P		F*				E*
Garbage trucks (truck-mounted solid waste compactor)			P		F	E*	S*	
Buses—school			P		F*	E*		
city								
intercity								
Motorcycles				P	F*	E*		
Identified as Major Noise Sources: truck-transport refrigeration units, power lawnmowers, pavement breakers, and rock drills								
Under Consideration: light vehicles, tires, chain saws, construction equipment								

P=proposed.
F=final regulations issued.
E=rule goes into effect.
S=more stringent noise limits go into effect.
* Projected dates.

Source: U.S. Environmental Protection Agency, Office of Noise Abatement and Control, *EPA Noise Control Program, Progress to Date* (Washington, D.C.: U.S. Government Printing Office, April 1979).

Besides standards on newly manufactured products, EPA has issued in-use regulations for locomotives and rail cars used in interstate commerce and has proposed them for other railroad equipment and facilities. These regulations are enforced by the Federal Railroad Administration of DOT.

Since 1975, interstate motor carriers also have been covered by EPA's in-use standards, which have proven effective in getting the worst noise offenders off the highways. The Bureau of Motor Carrier Safety of DOT actively enforces these standards.

FAA is responsible for issuing noise limits for new types of aircraft. The Federal Air Regulation (FAR) noise limits on new types of aircraft were established in 1969[115] and in 1977, and now cover most types of aircraft including jet transports and propeller-driven aircraft.[116] There is also a "retrofit or replacement" rule requiring all existing subsonic jet transport aircraft to meet at least the 1969 limits by 1985. In 1979 FAA proposed noise limits for new helicopters.

An important development in 1978 was the resolution of the Concorde issue.[117] The original 16 Concordes were allowed to continue operating in the United States, although with various restrictions. The FAA did not rule on which airports they could use, but left that decision to the 13 individual airports identified in the environmental

The 16 Concordes operating in the United States at times exceed the noise levels allowed for subsonic aircraft. No more Concordes are expected to be built.

impact statement accompanying the FAA rule. Dulles (Washington, D.C.) and John F. Kennedy (New York) airports have received Concordes because they were part of FAA's original 16-month test program. The Concordes also use Dallas-Fort Worth and, in the near future, may use Atlanta. The FAA prohibited scheduling of Concorde flights to U.S. airports between 10 p.m. and 7 a.m. local time, and prohibited modifications to the aircraft that would increase their noise. FAA also issued new aircraft noise rules for all Concordes after the first 16; those rules are equivalent to the noise levels prescribed in 1969 for newly designed subsonic aircraft. The fact that only 16 of the first generation Concordes can operate in the United States limits the amount of noise impacts they can create; it will be up to local authorities to determine how the noise impacts are distributed among airports.

OCCUPATIONAL NOISE

The protection of workers from excessive noise on the job is an area of increasing public concern and controversy. The Occupational Safety and Health Administration (OSHA) is charged with developing and enforcing rules to prevent excessive noise exposure.

OSHA's mandate is that *no* employee should suffer material impairment of health or functional capacity even if the employee is regularly exposed to a hazard covered by an OSHA standard *for the period of his working life.*[118]

There has been a federal standard in effect for some time to protect workers from noise exposure. Maximum limits are a function of the exposure time. For example, an 8-hour exposure to 90 dB would constitute a maximum permissible daily exposure; so would 115 dB for 15 minutes. The level at which the standard should be set has been a matter of controversy. OSHA proposed a revised standard in 1974 that would keep 90 dB for 8 hours, but would tighten other parts of the existing regulation. This proposed revised standard has not yet been adopted. On the basis of research studies, EPA concluded that the 90 dB was not adequately protective. Under authority of the 1972 Act, EPA recommended that OSHA adopt a more stringent standard of 85 dB for 8-hour exposures, as well as a 3 dB or "equal-energy" rule instead of the present 5 dB rule for trading off duration for intensity.[119]

The economic costs associated with workplace noise regulations have been difficult to determine. One analysis has shown that U.S. industry would have to spend up to $10.5 billion to comply immediately with the 90 dB requirement and an additional $8 billion to comply with an 85 dB requirement. Substantially less would be required if the period allowed to achieve compliance were lengthened.[120]

Hearing protectors have sometimes been advocated as an all-purpose alternative to engineering controls of noise, but they are an inferior alternative. It is true that hearing protectors are by far the least expensive method for reducing noise exposure, but there are several disadvantages. The main problem is that workers resist wearing them, either because they need to hear the sounds around them for reasons of safety or communication, or because the devices are uncomfortable. In addition, their effectiveness in practice is limited. A recent study by the National Institute for Occupational Safety and Health surveyed 168 workers wearing earplugs on the job. It revealed that half of the workers tested were getting less than one-third of the decibel reduction specified by the manufacturer, either because they were using the wrong size earplugs or not inserting them properly.[121]

LABELING

For products capable of making noise that could adversely affect the public health and welfare, EPA is responsible for product labeling to provide information to the prospective user on how much noise a product generates or how well certain products, such as hearing protectors or acoustic tile, reduce noise exposure.[122]

EPA has proposed a rule for labeling hearing protectors[123] and expects to issue a final rule in 1979. The agency has developed mini-

mum standards for voluntary labeling programs that may be submitted to EPA for review and, if consistent with federal guidelines, may be adopted as an alternative to federal labeling requirements.

FEDERAL ASSISTANCE TO STATES AND LOCALITIES

Because federal standard-setting alone cannot achieve desirable community noise levels, state and local programs are an essential complement. The Noise Control Act as modified by the Quiet Communities Act provides the framework for a federal partnership with states and localities in achieving a balanced national noise control program.

One facet of this partnership is EPA's program for financial assistance to help communities launch noise control programs. This is not long-term assistance; instead it is designed to help communities identify their particular noise problems and build programs in response.[124]

Other federal agencies offering financial support for noise control include the Federal Highway Administration which, as mentioned, provides funding through states for noise barriers and other measures.[125] The FAA has an Airport Development Aid Program (ADAP) fund of approximately $500 million per year, part of which is available for land purchase and noise abatement measures around airports. As of December 1978, FAA has spent almost $22 million for noise control under this program. FAA has also given about $4 million to local airports for noise planning.[126] The Department of Defense has a program to reduce the impact of noise near its military airfields, which includes purchasing of land and easements around them. In Florida, for instance, the Navy's Cecil Field is surrounded by the city of Jacksonville. The Navy has spent $1.9 million to buy land interests for no-building zones at the end of the runways and has also encouraged compatible land use zoning by the city.[127]

HUD has a uniform policy, applicable to all forms of HUD assistance, that requires noise planning in new residential construction or in substantial rehabilitation of existing units with unacceptable noise levels.[128] The policy was updated in 1979.[129] Both VA and HUD have policies of not approving mortgage assistance for housing in excessively noisy areas.

Regional Technical Assistance Centers, provided by the Quiet Communities Act, will be established under EPA sponsorship at universities or other institutions with expertise to assist communities and states. EPA will fund at least one center through each of its regional offices.

In EPA's Each Community Helps Others (ECHO) program, communities share their experiences in noise control with other cities and towns, through community noise advisors. ECHO advisors are experienced in various aspects of noise control and serve on a volunteer basis to provide onsite assistance for particular noise problems.[130]

EPA is emphasizing the creation and strengthening of state noise control programs. States can assume much of the responsibility for providing technical assistance to communities, in the manner of the federal ECHO program.[131]

URBAN NOISE PROGRAM AND OTHER INTERAGENCY COORDINATION

One method for strengthening the national noise control effort is the coordination of federal programs. The pursuit of noise reduction can be combined with other urban improvement goals through better coordination of existing federal programs to:[132]

A quiet lawnmower, suitable for use on hospital grounds, was developed in EPA's cooperative federal-state-local "buy-quiet" program. Photographer: Bruce L. Wolfe.

- Combine soundproofing and energy "weatherization" of noise sensitive buildings, such as schools and hospitals;
- Promote quieter design in transportation projects affecting urban areas;
- Improve urban development planning so that housing will be located away from major noise sources;
- Establish "buy-quiet" programs in federal, state, and local governments to create an early market for quiet products; and
- Support neighborhood self-reliance efforts to identify and solve local noise problems.

Another opportunity for federal coordination is in noise effects research. During 1978, the Federal Agency Noise Research Panel on

SOME FEDERAL TOOLS AVAILABLE TO STATES AND COMMUNITIES

- "AICUZ" Studies—"Air installation compatible use zones." Reports have been completed on over 115 military airfields or facilities (DOD)
- *Model Noise Ordinance* (EPA)
- *Airport Noise Control and Land Use Compatibility (ANCLUC) Planning Under the Planning Grant Program,* 1977 (FAA 5900.4)
- *Airports—Land Use Compatibility Planning,* 1977 (FAA Advisory Circular 150/5050–6)
- *Community Strategy Guidelines* (EPA)
- The Federal Highway Administration methods to be used in predicting highway noise levels ("Procedures for Abatement of Highway Traffic Noise and Construction Noise," FHPM 7–7–73)
- *The Audible Landscape: A Manual for Highway Noise and Land Use* (The Federal Highway Administration guidance to localities for land-use planning near highways, reprinted 8/76)
- *Community Noise Assessment Manual* (Social Survey Workbook and Acoustical Survey Workbook) (EPA)
- ECHO Community Noise Advisors (EPA)
- Federal Highway Administration procedures for evaluating the noise reduction from barriers, elevated and depressed highway sections, and roadside structures. ("A Field Evaluation of Traffic Noise Reduction Measures," National Cooperative Highway Research Report 144)
- A one-week training course on highway noise and abatement. ("Fundamentals and Abatement of Highway Traffic Noise," Federal Highway Administration)
- *Noise Barrier Design Handbook* (Federal Highway Administration: FHWA–RD–76–58)
- Federal Highway Administration procedures for determining the acoustical insulation of planned or existing buildings against highway noise ("Insulation of Buildings Against Highway Noise," FHWA–TS–77202)
- Technical assistance from EPA Regional Offices

Noise Effects, the National Academy of Sciences Committee on Hearing and Bioacoustics, and the International Commission on the Biological Effects of Noise focused on the effects of noise on health. These groups agreed that further investigation is needed, particularly on the nonauditory effects of noise, including noise as it relates to cardiovascular disease, sleep disturbance, and reproductive effects; and interactive effects of other factors (such as chemical and physical agents) with noise.[133]

Research and demonstration projects in noise-control technology were emphasized in the 1978 Quiet Communities Act. Four interagency noise research panels have reviewed current and planned federal research, development, and demonstration programs in the areas of noise effects, surface transportation noise, machinery and construction noise, and aircraft noise. EPA concluded that the federal programs did not meet the needs for successful implementation of a national noise abatement strategy.

Research and technology demonstrations will assume an even more important role as noise levels continue to escalate. As better noise abatement technology becomes available, more stringent regulations will be practicable to attain more desirable noise levels. EPA's Quiet Heavy Truck Demonstration Program is an example of such a project. Five 1978 vehicles, representing all of the major truck and truck engine suppliers, will be modified to noise levels significantly below those required by current regulations. This demonstration program may be extended to include medium trucks and tires.[134]

QUIET IN WILDERNESS AREAS

A special issue is the preservation of lasting peace and quiet appropriate to wilderness areas where noises that would not be noticed in another environment can have a significant impact. For example, there has been a debate on the proper use of the Boundary Waters Canoe Area (BWCA) in Minnesota, where motorboats can be heard up to 2 miles away on a still night.[135] A compromise solution was reached with the passage of a federal law in 1978 that placed restrictions on the continued use of motorboats, snowmobiles, and logging equipment within the BWCA.[136] Under the law, during the next 15 to 20 years, motorboats will be restricted to using 25 percent of the BWCA instead of the present 60 percent. Use of snowmobiles will be phased out completely during a 5-year period, and logging operations, already restricted since 1972, will be halted permanently.

Wilderness quiet is also at stake in the Grand Tetons, where there have been repeated attempts to introduce commercial jet service into Jackson Hole Airport, the only airport located within the confines of a national park. Measurements there have shown that sound levels in the absence of aircraft noise are extremely low—as low as 20 dB—causing aircraft noise impacts to be greater than they would be in typical urban settings. Existing aircraft noise levels from private and commercial aircraft are already having a significant effect on the

Commercial jet service has been proposed for Jackson Hole Airport in the Grand Tetons National Park, Wyo., raising the issue of noise intrusion in national park and wilderness areas. Photographer: George A. Grant.

park's pristine values, but the introduction of the B–737 jet would increase the zone of impact still farther—from 31 square miles from existing propeller commercial service, to at least 140 square miles. The increased impact would be even greater in terms of encroachment of audible aircraft noise into areas where such noise is now inaudible.[137]

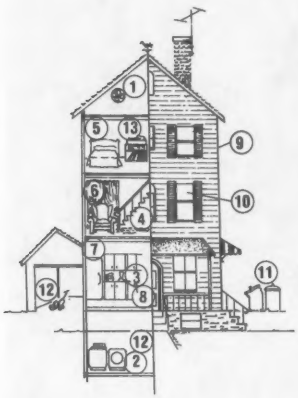
A related problem is the effect of noise on wildlife. There is evidence that noise may have adverse effects on some animal populations.[138] EPA is presently reviewing available information on this question.

PUBLIC AWARENESS AND PARTICIPATION

Public education on the national, state, and local levels is an important element of successful noise control. Citizens must be informed about the effects of noise on their health and welfare and about what they can do to minimize those effects. An EPA booklet, "Noise: A Health Problem," summarizes current information on the adverse health effects of noise.[139] The agency also distributes booklets to school children about hearing loss and how it can be avoided.

Figure 9–7

What You Can Do to Quiet Your Home and Protect Yourself From Noise



Inside

1. Install exhaust fan on rubber mounts
2. Use vibration mounts under electrical appliances like washer, dryer, and dishwasher
3. Put foam pads under blenders, mixers, and other small appliances (also your typewriter!)
4. Use wall to wall and stair carpeting with felt or rubber padding to dampen noise.
5. Use acoustical tile, spaced below ceiling
6. Install drapes to absorb sound
7. Buy quiet appliances
8. Install floor vinyl or thick linoleum to dampen sound

Outside

9. Eliminate noise leaks in walls by sealing holes or cracks
10. Caulk windows and install storm windows to cut down outside noise
11. Replace metal garbage cans with plastic ones

Protecting Your Ears

12. Wear ear protectors when you are using very noisy equipment or tools
13. Keep the stereo volume down

Source: Adapted from National Bureau of Standards Handbook 119, "Quieting—A Practical Guide to Noise Control, 1976".

The National Information Center for Quiet has been established as part of a coordinated education effort by a consortium of professional associations. The Center, located in Arlington, Va., will function as a national clearinghouse of information on noise abatement and control (see Figure 9–7) and will work with national voluntary organizations and civic groups.[140]

Public participation is also a key element of EPA's noise effort. Contributions are solicited in all phases of the rulemaking process from the public, state and local government officials, and manufacturers.

THE UNITED STATES AND ACTIVITIES IN OTHER COUNTRIES

Noise control activity has not been limited to the United States. The European countries and Japan have been very active. For example, they now regulate noise emissions at the source for a greater number of newly manufactured products than does the United States.[141] They also use most of the other approaches used here, and some different ones as well.[142] Many other countries, including the Soviet Union, also have numerous noise control regulations.[143] Major

efforts are now being made to standardize noise emission limits for new products so that they will not be a barrier to trade.[144]

CONTINUING PROBLEMS

Noise is a serious and enduring environmental problem. Surveys and national polls underscore the public's concern. Quiet is a highly valued commodity that we must take care to preserve. There are many important issues still to be resolved that demand immediate attention.

Learning more about the effects of noise on health should be high on the agenda. The evidence that suggests a link between noise and a wide range of health problems, in addition to hearing loss, suggests directions for research. Noise is suspected of contributing at least indirectly to cardiovascular disease, psychological and social problems, learning difficulties, and malfunction of a wide variety of bodily systems. These clues must be followed up, especially the possible link with cardiovascular disease.

Federal activity by itself will never be sufficient to maintain effective noise control; local resources will have to be tapped if U.S. citizens are to enjoy a quiet environment. Local noise control programs have made strides, but the task is often more complex than is at first apparent. Yet state and local officials are often lagging behind citizens in their concern about noise. The current trend is toward reduced municipal services, which may mean cutbacks in noise programs.

Although not as extensive as surface transportation noise, aircraft noise is perhaps the most acute problem outside the workplace. Reduction of aircraft noise at the source is beyond the control of local jurisdictions, but local communities and airports can still develop important noise abatement programs. There is no guarantee that future SSTs will be even as quiet as today's subsonic aircraft, which are already too noisy for many of the nation's airports. However, reduction of aircraft noise is possible and essential for restoring and maintaining acceptable levels of quiet for millions of U.S. citizens.

The potential for state and local initiatives remains largely untapped and may be the deciding factor in developing effective noise control. It will be very important for states or localities to complement federal efforts by providing sale and in-use regulations for major noise sources. States can also help in such areas as offering technical support to localities or in establishing statewide regulations. They can serve as the link between federal and local efforts by insuring that federal regulations are adopted and adequately enforced and by taking a more active role in areas where local governments are unable to meet their responsibilities.

A revised OSHA occupational noise standard is needed as soon as possible to give better protection to the nation's workers. Noise is a 24-hour problem; workers do not put on a second set of ears when

they go home. Federal interagency cooperation is necessary in order to coordinate noise control programs. Better coordination of federal research is also needed. The Quiet Communities Act of 1978 reemphasized the need for continued noise abatement technology research, including demonstration programs, to insure that future trends would not adversely affect the future environment. Yet the total amount of federal funds available for noise research has declined in recent years. Finally, low-noise areas are becoming rarer—both areas of relative quiet where people live, and areas of true quiet in remote wilderness areas. Low-noise areas should be protected so that people will have access to silence when they need it.

As the list of problems suggests, much work remains to be done on our national noise problem. Efforts to date have slowed, but not halted, the spread of noise. It is clear from the trends that the noise problem in the United States will continue to worsen unless continued federal activity is combined with expanded state and local programs for a broad national effort to control noise.

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CHAPTER 10

NEPA

The enactment of the National Environmental Policy Act[1] (NEPA) 10 years ago began a new era of federal decisionmaking. NEPA directs federal agencies to plan their policies and actions in light of the environmental consequences. To insure that environmental factors receive adequate consideration and environmental effects are understood in advance, NEPA directs federal agencies to prepare an environmental impact statement (EIS) for any major federal action significantly affecting the quality of the human environment. These environmental statements must identify and discuss the environmental effects of the proposed action and spell out, analyze, and compare alternatives. During the past decade, EISs have many times served as the focus of public debate and led to improvements in decisions on such diverse issues as major energy pipelines, water resource projects, nuclear powerplants, and public land management.

NEW NEPA REGULATIONS

Although there is broad agreement on the value of the environmental impact statement, the EIS process has been criticized for creating excessive paperwork and causing needless delays in worthwhile projects. Moreover, partly because cumbersome length and detail have obscured important issues,[2] EISs have been less useful to decisionmakers than they might have been. To correct these problems and improve the entire NEPA process, President Carter in 1977 directed the Council on Environmental Quality (CEQ) to issue regulations to implement more effectively the procedural requirements of NEPA.[3] The Council's NEPA regulations were proposed for public comment in June 1978,[4] and were promulgated in final form in November 1978.[5] The new regulations replace the Council's advisory EIS Guidelines and are binding on all federal agencies. They implement NEPA's procedures for building environmental awareness into federal agency actions, from early planning to monitoring environmental quality measures of completed projects. They are designed to produce more useful, readable, tightly focused documents and to reduce delays through a variety of changes in procedures to be employed from the start to the finish of the environmental review proc-

ess. The regulations became effective on July 30, 1979.[6] All federal agencies were required to adopt procedures implementing the regulations by that date.[7]

SCOPING

One of the most significant innovations in the new NEPA regulations is the "scoping" process.[8] When a federal agency determines that a proposed action requires preparation of an EIS, it must take prompt action, at the very beginning of the planning process, to identify the important issues that require full analysis and to separate those issues from the less significant matters that do not require detailed study. The scoping process also helps to identify any environmental review and consultation requirements imposed by laws other than NEPA and to allocate responsibilities among lead and cooperating agencies. Affected federal, state, and local agencies, and interested members of the public must be invited to participate in this scoping process.

RECORD OF THE DECISION

Another important innovation is the requirement that when an EIS has been prepared, the agency must produce a written record of its decision on the proposal analyzed in the EIS.[9] This document must concisely identify the alternatives considered, specify which alternatives were environmentally preferable, and explain the considerations weighed in reaching the decision. In addition, the record of the decision must state whether all practicable means for mitigating environmental harm have been adopted and, if not, why not. The agency must provide for monitoring to assure that its decision is carried out and must implement those mitigation measures that the agency committed itself to undertake as part of the decision. For example, if in an EIS for a proposal to build power transmission lines across public land, the agency commits itself to certain design and route changes to mitigate adverse environmental effects, then the permit authorizing building of the lines must be conditional on incorporation of those design changes.

FORM AND CONTENT OF EISs

The new regulations also call for changes in the form and content of EISs.[10] The new recommended format requires:

- A statement of the purpose and need for the project;
- A rigorous comparison of the reasonable alternatives;
- A succinct description of the environment of the area to be affected by the proposed project;

- A discussion of the environmental consequences of the proposal and of alternatives (including direct and indirect effects, energy requirements and conservation potential, mitigation measures, depletable resource requirements, impacts on urban quality and historic and cultural resources, and possible conflicts with state or local land use plans, policies, and controls);
- A list of the names and qualifications of the people primarily responsible for preparing the EIS and of the agencies to which the EIS was sent; and
- An index.

This format replaces the common practice of organizing the EIS according to the five subsections of Section 102(2)(C) of NEPA.

Impact statements must be analytic rather than encyclopedic and must be written in plain language. The regulations state that EISs should normally have fewer than 150 pages; EISs for proposals of unusual scope and complexity should normally have fewer than 300 pages.[11] The regulations also encourage "tiering,"[12] that is, the use of a program EIS for broad federal actions (such as the U.S. Department of the Interior's 5-year plan for Outer Continental Shelf Oil and Gas Exploration)[13] followed by more specific EISs for particular actions under the program describing site-specific consequences and alternatives.

CONFLICTS OF INTEREST

The regulations also address a long-standing controversy—the possibility of conflicts of interest when applicants for federal permit or funding approval participate in the environmental analysis of the project. The regulations require that the EIS be prepared by the federal agency or by a contractor selected by the agency, but allow a private entity to submit information for the agency to use in preparing the EIS if the information is independently evaluated by the agency.[14] Contractors must certify that they have no conflict of interest by signing disclosure statements specifying that they have no financial or other interest in the outcome of the project.

INTEGRATION WITH OTHER ENVIRONMENTAL REVIEW REQUIREMENTS

An important feature of the regulations is improved integration of NEPA procedures with other environmental review laws and federal permit requirements. Applicants for federal permits and licenses often face a variety of specialized environmental reviews (such as those under the Fish and Wildlife Coordination Act,[15] the Endangered Species Act,[16] and the National Historic Preservation Act)[17] in addition to the comprehensive environmental review required by NEPA. In the past, some projects have been needlessly delayed because of lack of coordination among agencies, sequential rather than concur-

rent compliance with permit and review procedures, failure to prepare environmental reviews early in the planning stage, insufficient guidance from federal agencies to applicants, and duplication between federal and state environmental review requirements.

The Council's new NEPA regulations address these problems in the following ways:

- Agencies having permitting, licensing, or other approval authority over a project are required to confer early in the planning of the project.[18] During the scoping process, agencies must identify significant environmental issues, identify applicable permit and environmental review requirements, and organize the preparation of the EIS in a way that consolidates and integrates these environmental reviews.[19]
- Agencies with jurisdiction by law over the project (e.g., permitting, licensing, or approval authority) must, when requested, cooperate with the lead agency in preparing the EIS. An agency having permit authority over a component of the project can no longer stay aloof from the EIS preparation and then at a later stage raise issues and conduct separate environmental reviews that could have been undertaken during EIS preparation.[20]
- To the fullest extent possible, the draft EIS is to be prepared concurrently with, and integrated with, any other environmental studies, reports, and analyses required by other federal statutes, regulations, and Executive orders.[21] In addition, the draft EIS must list all federal permits, licenses, or other entitlements that must be obtained to carry out the proposal.[22]
- For actions that are planned by private applicants or other nonfederal entities, agencies are required to develop procedures to advise potential applicants of studies or other information that foreseeably will be required for a later federal permit or approval. The agency must also indicate how it will consult at an early stage with appropriate state and local agencies, Indian tribes, interested private parties, and organizations.[23]
- In order to avoid delays in applying the NEPA process to federal permits or other approvals, environmental assessments or EISs must be started immediately after the application is received, preferably jointly with applicable state or local agencies.[24] In addition, an applicant may require that the lead agency set time limits on the NEPA review process, provided they are consistent with NEPA and other essential considerations of national policy.[25]
- Federal agencies with jurisdiction by law or special expertise over a project must comment on the draft EIS, and they must state in their comments what, if any, additional information they need to fulfill environmental review requirements for permits, licenses, or entitlements they issue.[26] Further, if a federal agency with jurisdiction by law objects to or expresses reservations about the project on environmental impact grounds, that agency must specify any mitigation measures it considers necessary to allow the project to proceed.[27]

- To minimize duplication, the new regulations allow a federal agency with permitting authority over one aspect of a project to adopt the EIS prepared by the lead agency without recirculating it for further review.[28]

These provisions will make it easier for applicants to comply with all permit and environmental requirements, will facilitate interagency coordination, and will assist agencies in arriving at consistent, environmentally sensitive decisions.

INTEGRATION WITH THE LEGISLATIVE PROCESS

NEPA requires impact statements on "proposals for legislation."[29] One of the most difficult problems in NEPA implementation during the years has been integrating the EIS process with the legislative process. The new regulations streamline the procedures for legislative EISs by allowing a single legislative EIS (instead of a draft and final) to be submitted to Congress under certain circumstances.[30] The single document must be available before the Congress begins formal deliberations on the proposal and, in any event, must be made available to Congress and the public no later than 30 days after the proposed legislation is submitted to Congress. Both draft and final legislative EISs (incorporating public comments) must be prepared under the following circumstances: when the relevant Congressional Committee requests it; when the proposal results from study processes such as those provided by the Wild and Scenic Rivers Act [31] and the Wilderness Act; [32] when legislative approval is being sought for construction or other specific projects at specific locations; and when the agency itself decides to prepare both draft and final statements.

COOPERATION WITH STATE AND LOCAL GOVERNMENT

Another innovation in the regulations is designed to eliminate duplication between NEPA and similar state and local environmental policy laws. The regulations require federal agencies to cooperate with state and local agencies to the fullest extent possible.[33] The regulations encourage joint planning and research and the use of a single document complying with both NEPA and state law. The federal EIS must discuss any inconsistency between the proposal and state or local plans or laws and the extent to which the agency will reconcile the conflict.

INTERNATIONAL APPLICATION OF NEPA

Whether and how to analyze the environmental impact of federal actions abroad had been an unresolved issue since the passage of NEPA in 1969. Although NEPA requires all federal agencies to "recognize the worldwide and long-range character of environmental

problems. . ." and to take appropriate actions consistent with U.S. foreign policy,[34] the question of whether an EIS must be prepared has been much debated. Agencies with specific environmental protection responsibilities have maintained that NEPA's EIS requirement applies to major federal actions having significant environmental effects on the oceans or on foreign countries. Other agencies—especially those more concerned with foreign, defense, and export policy—have held the opposite view. The courts have not decided the issue in the few lawsuits that have raised this question.[35]

After 7 years of divided opinion in government, the Carter Administration approached the issue in a way sensitive both to environmental and foreign policy concerns. After extensive consultation between CEQ and the Department of State, Executive Order 12114 was prepared and signed by President Carter on January 4, 1979.[36]

The Executive order has two principal provisions. First, federal agencies must prepare environmental impact statements for major federal actions that have significant environmental effects on the global commons (e.g., oceans and Antarctica).[37] Second, under certain circumstances agencies must prepare concise environmental reviews (or participate in bilateral/multilateral environmental studies) of the impacts of major federal actions in foreign countries:

- When the foreign nation affected is not participating with the United States in the project and is an "innocent bystander nation," (e.g., a U.S. financed dam in one foreign country that cuts off water in another);[38]
- When the federal action involves a facility that is strictly regulated or prohibited in the United States in order to protect against radioactive hazards (such as export of nuclear reactors);[39]
- When the federal action involves a product or a facility whose principal products, emissions, or effluents are prohibited or strictly regulated by federal law because their toxic effects on the environment create a serious public health risk (such as asbestos, vinyl chloride, acrylonitrile, isocyanates, polychlorinated biphenyls (PCBs), pesticides, mercury, beryllium, arsenic, cadmium, and benzene);[40] and
- When the federal action affects natural or ecological resources of global importance that are designated by the President or, in the case of resources protected by international agreement, the Secretary of State.[41]

The order allows certain exemptions and modifications of the procedures when necessary for national security or foreign policy reasons. Agencies may also add to the basic requirements of the order to further the purposes of NEPA and other environmental laws.[42]

By September 4, 1979, all federal agencies with activities outside the United States, after consultation with CEQ and the Department of State, are required to have procedures for implementing the order in effect.[43]

EVENTS IN THE COURTS

Even before CEQ's new regulations finally took effect on July 30, 1979, a unanimous Supreme Court relied on them extensively in deciding the question presented by *Andrus* v. *Sierra Club*.[44] The issue raised in that case was narrow: whether an environmental impact statement was required on requests for appropriations submitted to the Congress by federal agencies. In ruling that EISs were not required, however, the Court broadly endorsed the new NEPA regulations and the process by which they were developed.

In earlier judicial proceedings, the United States Court of Appeals for the District of Columbia Circuit had ruled that appropriation requests are "proposals for legislation" under NEPA that require environmental impact statements when the requests would result in a significant change in the status quo or represent a "new look" at an ongoing program.[45] The Secretary of the Interior and the Director of the Office of Management and Budget (OMB) sought Supreme Court review, contending that budget recommendations made to OMB or the President are not "proposals" under NEPA and that the term "legislation" in NEPA refers to substantive legislation, not appropriations.[46] To interpret NEPA otherwise, they argued, would be inconsistent with the confidentiality of the budget process and the Constitutional authority of the President.[47]

While the Court proceedings were underway, CEQ was evaluating precisely the same issue in connection with its development of the new NEPA regulations. It ultimately concluded "[o]n the basis of traditional concepts relating to appropriations and the budget cycle, considerations of timing and confidentiality, and other factors . . . that preparation of EISs is ill-suited to the budget preparation process." [48] Accordingly Section 1508.17 of the new regulations provides that "[l]egislation includes a bill or legislative report to Congress . . . *but does not include requests for appropriations.*" [49] (Emphasis added.) This was the one instance in the regulations where CEQ reversed the position taken in its 1973 guidelines. On review, the Supreme Court ruled:

> CEQ's interpretation of NEPA is entitled to substantial deference. See *Warm Springs Dam Task Force* v. *Gribble,* 417 U.S. 1301, 1309–1310 (1974) (Douglas, Circuit Justice). The Council was created by NEPA, and charged in that statute with the responsibility "to review and appraise various programs and activities of the Federal Government in the light of the policy set forth in this Act . . . , and to make recommendations to the President with respect thereto." [50]

Nor did the Council's reversal of its earlier position diminish its role here, according to the Court, in view of the process by which its current opinion was reached.

As the Supreme Court put it:

> It is true that in the past we have been somewhat less inclined to defer to "administrative guidelines" when they have "con-

> flicted with earlier pronouncements of the agency." . . . But CEQ's reversal of interpretation occurred during the detailed and comprehensive process, ordered by the President, of transforming advisory guidelines into mandatory regulations applicable to all federal agencies. . . . A mandatory requirement that every federal agency submit EISs with its appropriation requests raises wholly different and more serious issues "of fair and prudent administration," . . . than does nonbinding advice.[51]

The Court also noted that the position taken in the new regulations was consistent with the traditional distinction that Congress has drawn between "legislation" and "appropriations." [52] It further observed that the preparation of an EIS on requests for appropriations would be redundant when an environmental review had already been conducted on the underlying program for which the request was made.[53]

The Supreme Court's opinion in *Andrus* v. *Sierra Club* lends strong judicial support to the new NEPA regulations and CEQ's continuing efforts to reform the EIS process. The Court quoted extensively from the regulations on such diverse subjects as the purpose of environmental impact statements,[54] the timing of EIS preparation,[55] the definition of an EIS,[56] and the definition of "major federal action." [57]

NEPA's substantive provisions also continue to receive attention in the courts. Beginning its analysis in *Andrus* v. *Sierra Club,* the Supreme Court quoted NEPA's purposes and Section 101(b)'s goals and policies, stating:

> Congress recognized, however, that these desired goals could be incorporated into the everyday functioning of the Federal government only with great difficulty. . . . NEPA therefore contains "action forcing procedures which will help to insure that the policies [of the Act] are implemented." [58]

The Supreme Court went on to explain:

> The thrust of Section 102(2)(C) is thus that environmental concerns be integrated into the very process of agency decisionmaking. The detailed statement it requires is the outward sign that environmental values and consequences have been considered during the planning stage of agency actions. . . . If environmental concerns are not interwoven into the fabric of agency planning, the "action forcing" characteristics of Section 102(2)(C)) would be lost.[59]

Thus the Supreme Court in *Andrus* v. *Sierra Club* re-emphasizes the importance of NEPA's procedural requirements to insure agency consideration of NEPA's substantive goals and policies.

NEPA's substantive requirements were again supported by the Court's decision in *Public Service Co. of New Hampshire* v. *NRC,*[60] a case involving construction of the Seabrook nuclear power plant. The Nuclear Regulatory Commission's (NRC) Atomic Safety and Licensing Board, using NEPA as authority, conditioned the Seabrook

permits on the rerouting of power transmission lines around the Pow Wow River Cedar Swamp (the utility's proposed route was directly through the swamp). NRC justified these permit conditions under NEPA because transmission lines through the swamp would cause significant environmental damage to increasingly scarce and valuable stands of Atlantic White Cedar, and to the wildlife habitat of this important river-marsh ecosystem. NRC also determined that the 200-foot-high steel lattice work towers would constitute a "visual insult" to this relatively pristine area, and that practicable alternative routes existed.

Citing NEPA's substantive mandate in Section 101(b) that federal agencies are to "use all practicable means" to avoid environmental "degradation" and to preserve "natural aspects of our national heritage" to the extent consistent with "other essential considerations of national policy" the Court held:

> Once having found that the Commission has jurisdiction over the transmission lines, we think it clear that, under the dictates of NEPA, it was *obliged* to minimize adverse environmental impact flowing therefrom.[61] (Emphasis added.)

This decision continues and strengthens a series of NEPA cases holding that substantive requirements in NEPA's Section 101 and 102(1) give agencies authority to minimize adverse environmental damage, even when the agency's statutory charter does not authorize affirmative measures to protect the environment.[62]

Presidential authority was at issue in *State of Alaska* v. *Carter*.[63] In that case, Alaska challenged the steps taken by the President and the Secretary of the Interior to protect more than 100 million acres of public lands in Alaska from development, pending legislative

The state of Alaska challenged use of an abbreviated 25-day comment period on a draft EIS regarding actions by the President and the Secretary of the Interior to protect these and other Alaska lands. The Court upheld the legality of the President's action. Photographer: M. Woodbridge Williams.

action by Congress. The specific issue was the legality of using an abbreviated 25-day comment period on a draft EIS supplement considering alternative administrative actions by the President and the Secretary of the Interior for protecting "National Interest Lands" in Alaska. The state argued that the use of an abbreviated 25-day comment period violated NEPA and CEQ guidelines. The court declined to issue a preliminary injunction, holding that neither the actions of the President nor the Secretary's recommendations to the President are subject to the EIS requirement. The court also ruled that emergency withdrawals of public lands from development by the Secretary under the Federal Land Policy and Management Act do not require an EIS. Finally, the court concluded that the 25-day comment period that had been decided upon in consultation with CEQ did not violate NEPA or the guidelines. The court reasoned that the Council has considerable discretion to tailor NEPA procedures to the circumstances of the case.

Another case involving actions in Alaska has raised the question of whether the *failure* to take a particular action can be considered a "significant action affecting the environment" and thus be subject to NEPA provisions. A potential conflict exists between the Ninth Circuit and the District of Columbia Circuit concerning this question. In 1977, animal welfare groups sought to halt a wolf-control program that Alaska proposed to conduct on public lands administered by the Department of the Interior. The District Court for the District of Columbia issued a preliminary injunction ordering the Secretary of the Interior to prepare an EIS before allowing the state program to proceed.[64] The fact that the federal government was not funding or directly participating in the program, noted the court, did not preclude its action from being a major federal action under NEPA. The court stated that because the Secretary's failure to stop the state's wolf kill allowed the program to go forward, a decision that significantly affected the environment, NEPA's requirements were applicable. The Department of the Interior appealed the District Court's preliminary injunction order to the District of Columbia Circuit.

Alaska, not a party to the District of Columbia suit, filed its own action in the United States District Court for the District of Alaska. However, the Alaska Court held that, although the Secretary had the power to halt the wolf-control program, no EIS was necessary if he refrained from exercising that power.[65] The Ninth Circuit, in *Alaska* v. *Andrus*[66] affirmed this decision. NEPA, the Ninth Circuit stated, mandates that federal agencies file impact statements when they propose to take a *leading* role in activities affecting the environment. Where no federal funds are to be spent, nor federal agents employed in the activity, mere nonexercise of a power of supervision does not constitute federal action sufficient to trigger NEPA's EIS requirement.

Soon after the Ninth Circuit issued its opinion, the District of Columbia Circuit, in an unpublished order, dismissed the case in the

District Court partly on the grounds that changes in the status of the affected Alaska lands had given plaintiffs essentially the relief they sought, and partly on the grounds of comity in light of the Ninth Circuit's opinion.[67]

In 1979, however, the state of Alaska again proposed to conduct a wolf-kill program on the public lands. When the Secretary failed to prepare an EIS, the same plaintiffs sought and obtained another preliminary injunction in the District Court for the District of Columbia.[68] Once again, the court stated that the Secretary's nonexercise of his power to stop the state program was major federal action requiring an EIS. The federal government is seeking summary reversal in the District of Columbia Circuit. Alaska was not a party to this action and did not file a second suit in the District Court of Alaska.

The failure of the U.S. Department of the Interior to file an EIS regarding its inaction on an Alaska wolf-kill program has been the focus of several court cases. The eastern timber wolf, shown above, is endangered. Photographer: L. David Mech.

Because of the comprehensive coverage of NEPA, many NEPA cases also raise issues involving other more specialized federal environmental review laws, such as the National Historic Preservation Act,[69] the Endangered Species Act,[70] and the Fish and Wildlife Coordination Act.[71] A few early cases seemed to suggest that compliance with NEPA is, by itself, *de facto* compliance with other environmental review requirements,[72] or that the specialized environmental review laws supersede NEPA with respect to matters subject to consideration under other environmental review provisions (e.g., wildlife conservation or historic preservation).[73] However, a clear majority of courts now recognize that although various federal environmental review laws are mutually reinforcing, each imposes distinct requirements that must be satisfied.[74] Thus, compliance with one environmental review law does not relieve an agency of its obligation to comply with the separate requirements of other laws, although compliance may be achieved concurrently, through integrated procedures. In order to avoid duplication, the new NEPA regulations require agencies, "to the fullest extent possible," to prepare draft EISs concurrently with and integrated with environmental analyses, and related surveys and studies required by other federal environmental review laws—such as the Fish and Wildlife Coordination Act, the National Historic Preservation Act, the Endangered Species Act, and Executive Orders 11988 and 11990 concerning Floodplain Management and Protection of Wetlands.[75] In this way, compliance with federal environmental review requirements will be simplified and streamlined, using the NEPA environmental assessment and EIS as umbrella environmental documents without sacrificing the requirements of the more specialized federal environmental laws.

TRENDS IN ENVIRONMENTAL LITIGATION

NEPA LITIGATION

During 1978, there were 114 lawsuits challenging federal actions under NEPA. This continues the levelling-off trend in NEPA litigation observed over the past 3 years.

The most frequent complaint in 1978 NEPA lawsuits, comprising 57 percent of all allegations, is that agencies should have prepared an EIS but failed to do so. The second most common allegation (30 percent of the total) is that an EIS is inadequate. This distribution has not changed significantly from previous years.

Five federal agencies accounted for 79 cases or 69 percent of 1978's NEPA litigation. The Department of Transportation led with 22 cases (19 percent), followed by the Department of Defense with 17 cases (15 percent), the Department of the Interior with 16 cases (14 percent), the Department of Housing and Urban Development with 12 cases (10.5 percent), and the Environmental Protection Agency with 12 cases (10.5 percent).

The types of federal actions or projects most frequently involved in NEPA litigation during 1978 were projects affecting wetlands and water bodies (16 cases or 14 percent); water and sewage treatment projects (14 cases or 12 percent); highway, roads, and trail construction (12 cases or 10 percent); and various federal policies, programs, plans, regulations, and standards (10 cases or 9 percent) (see Table 10–1).

Table 10–1

NEPA Litigation, by Type of Action Involved, 1978

Type of Federal Action or Project	Numbers of NEPA Lawsuits Filed in 1978	Cases Resulting in Injunctions (average duration)
Projects affecting wetlands and water bodies	16	4 (8 months)
Water and sewage treatment projects	14	none
Highway and road construction	12	1 (12 months)
Policies, programs, plans, regulations, and standards	10	1 (3 months)
Subsidized housing	9	1 (6 months)
Energy projects	9	2 (8 months)
Mass transit	8	1 (2 months)
Actions involving public lands (other than energy and water)	8	none
Military activities	8	1 (12 months)
Air transportation activities	7	1 (12 months)
Wildlife-related	5	none
Actions affecting historic sites	5	2 (5 months)
Miscellaneous actions	10	1 (10 months)
Total	[a] 121	15 (7.8 months)

[a] Exceeds total of 114 lawsuits filed in 1978 because some cases involved two types or categories of federal actions.

During 1978 citizen and environmental groups were among the plaintiffs in 52 NEPA cases (45 percent), individuals were plaintiffs in 36 cases (31 percent), local governments were plaintiffs in 21 cases (19 percent), business and industry were among the plaintiffs in 20 cases (19 percent), and state governments were plaintiffs in 10 cases (9 percent). (Percentages total more than 100 because many cases were brought by more than one type of plaintiff.) This distribution indicates that local governments, business, and industry brought a relatively higher percentage of NEPA lawsuits in 1978 than in previous years (19 percent compared with a cumulative average in previous years of 12 and 15 percent respectively). Environmental groups and individuals initiated relatively fewer NEPA lawsuits (45 percent and 31 percent respectively in 1978; compared with a cumulative average in previous years of 67 and 52 percent respectively).

During the first 9 years after NEPA's enactment (January 1, 1970 through December 31, 1978) 70 federal agencies prepared more than 11,000 EISs on their major federal actions significantly affecting the environment. Every year agencies make many times that number of

brief environmental assessments that help guide decisions on whether to prepare a full EIS.

During the 9-year period, 1,052 NEPA lawsuits were filed. This represents less than 10 percent of all federal proposals for which an EIS was prepared. In the 9 years, courts issued injunctions related to NEPA matters in 217 cases (about 20.6 percent of all NEPA lawsuits, but only about 2 percent of all projects involving the preparation of an EIS).

A review of these 1,052 NEPA lawsuits reveals that 103 cases involved specific energy projects. Table 10–2 summarizes the type and number of energy projects involved in NEPA lawsuits. It shows that 50 of the cases involved electric power plants, of which 30 were nuclear powerplants, and 15 cases concerned electric transmission lines.

Table 10–2

NEPA Litigation Involving Energy Projects, by Type of Project, 1970–78

Type of Energy Project	Number of NEPA Lawsuits as of December 31, 1978	Number of Cases Resulting in Injunctions
Nuclear power plants and projects	30	2
Electric transmission power lines	15	1
Hydroelectric power projects	11	4
Outer continental shelf oil and gas lease sales (OCS)	10	3
Coal prospecting and mining activities	10	2
Fossil fuel power plants	9	1
Oil and gas drilling projects (other than OCS)	8	2
Miscellaneous energy projects	6	2
Pipelines	4	0
Total	103	17

About half of these cases involved energy projects for which the federal agency with lead responsibility failed to prepare an EIS. CEQ anticipates that this kind of NEPA lawsuit will significantly decline in the future, especially in light of the NEPA regulations that went into effect July 30, 1979. In the remainder of cases, inadequate compliance with NEPA's procedural requirements was alleged, often as a subsidiary claim (that is, where the principal legal claim was a violation of a statute other than NEPA).

The review showed that of the 103 NEPA lawsuits involving energy projects, only 17 resulted in temporary or preliminary injunctions related to NEPA issues.

CEQ's review suggests that NEPA litigation and preliminary injunctions have not presented a significant obstacle to the development of energy projects. On the other hand, NEPA's requirements, which have been systematically enforced by the courts, have produced effective mitigation measures and more careful consideration by federal agencies of less environmentally damaging alternatives for

proposed energy projects. The presence of the injunction remedy, sparingly used by the courts,[76] probably has provided an impetus for federal agencies to observe NEPA's requirements in decisions involving energy projects.

FEDERAL ENVIRONMENTAL LITIGATION OTHER THAN NEPA

Federal environmental laws[77] other than NEPA have been the subject of increasing litigation. Most of the cases have been industry challenges to EPA implementing regulations and permit decisions. The Department of Justice reports that environmental pollution lawsuits brought against and initiated by the federal government increased from 582 pending matters at the end of 1973 to 1,781 pending matters at the end of 1978. The increase continued in 1979, reaching 1,809 at the end of the first 3 months. Virtually all of this growth is in EPA civil cases. The rise is occurring equally rapidly in cases against the government and in enforcement cases brought by the government (see Figure 10–1).

Roughly two-thirds of the approximately 750 lawsuits pending against EPA at the end of 1978 have been industry challenges to regulations (see Figure 10–2). By comparison, citizen lawsuits and mandatory court enforcement actions represent less than 15 percent of lawsuits against EPA.

Until 1976 most environmental lawsuits initiated by EPA were brought to enforce the Federal Water Pollution Control Act. Since 1976, Clean Air Act enforcement actions have also increased (see Figure 10–3). EPA enforcement lawsuits involving more recent federal environmental statutes such as the Toxic Substances Control Act, the Resource Conservation and Recovery Act, and the Federal Insecticide, Fungicide, and Rodenticide Act, are expected to rise significantly by 1980 to 1981.

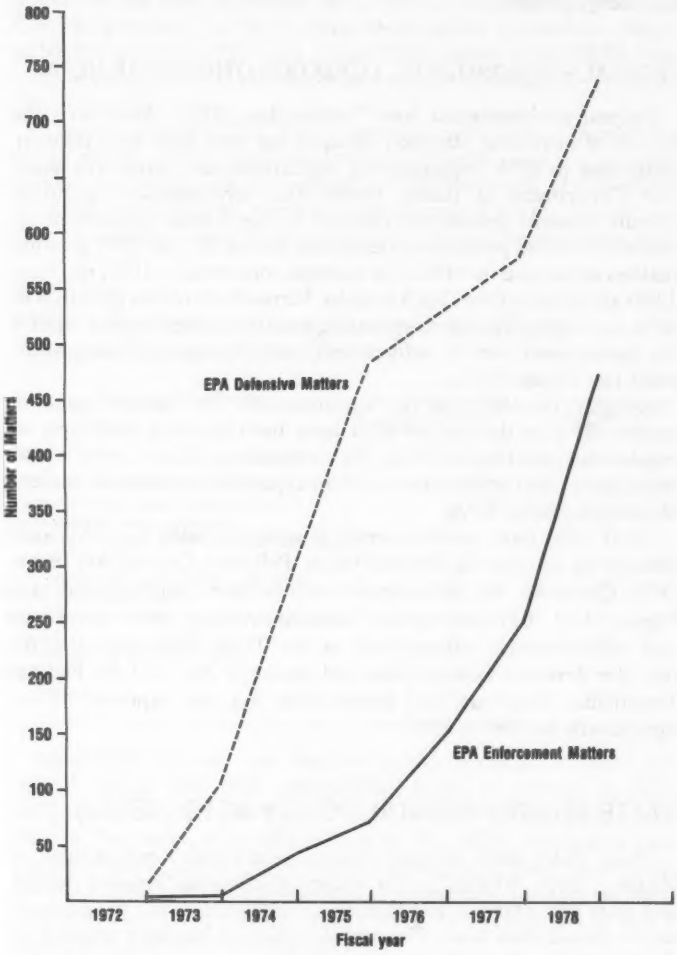
STATE ENVIRONMENTAL POLICY ACTS (SEPAs)

Many states have adopted environmental policy acts similar to NEPA ("little NEPAs"). To reduce duplication between NEPA and state procedures, CEQ drafted a model statute for the states to use to amend their laws. The model legislation has been adopted by the Council of State Governments and has been submitted to the states. It complements Section 1506.2 of the Council's NEPA regulations, which directs federal agencies to cooperate with state and local agencies in eliminating duplication between NEPA and comparable state and local requirements. (The NEPA regulations are reprinted in Appendix F of the 1979 CEQ Annual Report.) The Council has urged all states with SEPAs to adopt this proposal.

A summary of state environmental impact statement requirements appears in Table 10–3.

Figure 10–1

EPA Civil Caseload [a]

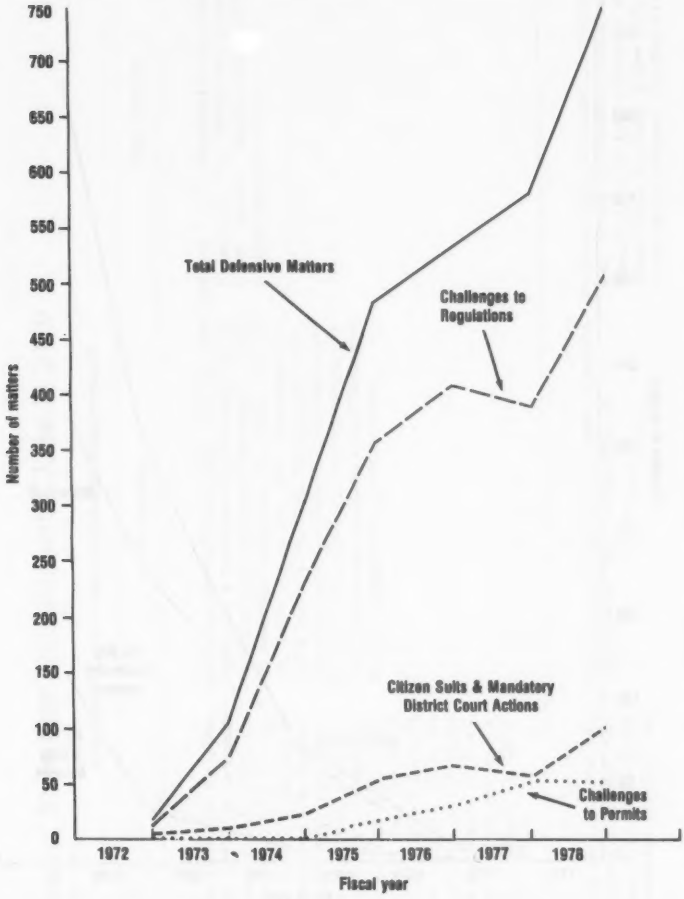


[a] Pollution cases only.

Source: U.S. Department of Justice, Land and Natural Resources Division.

Figure 10–2

EPA Defensive Civil Caseload [a]

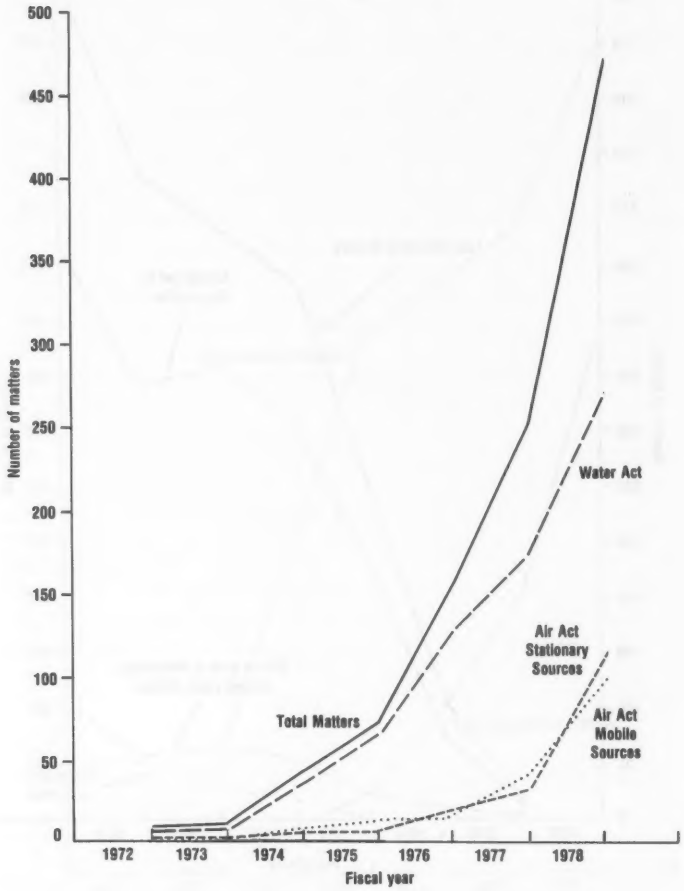


[a] Pollution cases only.

Source: U.S. Department of Justice, Land and Natural Resources Division.

Figure 10–3

EPA Enforcement Civil Caseload [a]



[a] Pollution cases only.

Source: U.S. Department of Justice, Land and Natural Resources Division.

Table 10–3

State Environmental Impact Statement Requirements, June 1, 1979

States With Comprehensive Statutory Requirements

Source	Guidelines	State Contact
California		
California Environmental Quality Act of 1970, Cal. Pub. Res. Code, Section 21000–21176 (Supp. 1972), as amended by: Ch. 1154, Statutes of 1972, December 5, 1972; Ch. 895, Statutes of 1973, September 28, 1973; Ch. 56, Statutes of 1974, March 4, 1974; Ch. 276, Statutes of 1974, May 21, 1974; Ch. 1187, Statutes of 1975, September 30, 1975; Ch. 593, Statutes of 1976, August 27, 1976; Ch. 753, Statutes of 1976, September 7, 1976; Ch. 1312, Statutes of 1976, September 29, 1976; Ch. 854, Statutes of 1977, eff. Jan. 1, 1978; Ch. 1045, Statutes of 1977, eff. Jan. 1, 1978; Ch. 1200, Statutes of 1977, Sept. 30, 1977, eff. Jan. 1, 1978; Ch. 308, Statutes of 1978, eff. June 30, 1978; Ch. 291, Statutes of 1978, eff. Sept. 15, 1978; Ch. 760, Statutes of 1978, eff. Jan. 1, 1978; Ch. 356, Statutes of 1978, eff. July 5, 1978; Ch. 1075, Statutes of 1978, eff. Sept. 25, 1978; Ch. 1091, Statutes of 1978, eff. Jan. 1, 1979; Ch. 1113, Statutes of 1978, eff. Sept. 25, 1978; Ch. 1271, Statutes of 1978, eff. Jan. 1, 1979.	California Administrative Code, Title 14, Division 6, Ch. 3 (Sections 15000 through 15192) and appendices adopted February 3, 1973, as amended December 14, 1973, January 18, 1974, March 26, 1974, December 30, 1974, January 30, 1975, February 18, 1975, January 6, 1976, October 8, 1976, December 8, 1976, December 23, 1976, February 4, 1978. Guidelines prepared by the Resources Agency of California (under revision).	Norman E. Hill, Assistant to the Secretary for Resources, The Resources Agency, 1414 Ninth Street, Sacramento, Calif. 95815 (Phone: 916–445–9134).
Connecticut		
Connecticut Environmental Policy Act of 1973, Pub. Act 73–562 (approved June 22, 1973), Conn. Gen. Stat. Ann. Ch. 439, Section 22a–1 *et seq.* (Cum. Supp. 1974–1975), effective February 1, 1975, as amended by: Pub. Act 77–514, effective October 1, 1977.	Regulations of Connecticut State Agencies, Section 22a–1(a)–1 to 22a–1(a)–12.	Jonathan Clapp, Principal Environmental Analyst, Office of Planning and Coordination, Department of Environmental Protection, State Office Building, Room 114, Hartford, Conn. 06115 (Phone: 203–566–3740).

Table 10–3 (continued)

States With Comprehensive Statutory Requirements—Continued

Source	Guidelines	State Contact
Hawaii		
Governor's Executive Order of August 21, 1974, as supplemented by Act 246, Sess. Laws of Hawaii (approved June 4, 1974), Hawaii Rev. Stat. Ch. 343 (1974), as amended June 1979.	"Rules and Regulations Pertaining to Chapter 343," promulgated in September 1975 by the Hawaii Environmental Quality Commission (under revision).	Richard O'Connell, Director, Office of Environmental Quality Control, Office of the Governor, 550 Halekauwila Street, Room 301, Honolulu, Hawaii 96813 (Phone: 808–548–6915).
Indiana		
IC 1971, 13–1–10–3, added by Pub. L. 98, 1972, Ind. Stat. Ann. Section 1–301(c) (effective July 1, 1975).	EMB–2; "The Definition of Actions of State Agencies Which Have a Significant Environmental Impact," effective August 7, 1975.	Ralph Pickard, Technical Secretary, Environmental Management Board, 1330 W. Michigan Street, Indianapolis, Ind. 46206 (Phone: 317–633–8405).
Maryland		
Maryland Environmental Policy Act of 1973, Ch. 702, Md. Acts of 1973, 41 Ann. Code of Md., Section 447–451 (Cum. Supp. 1973), and Ch. 703, Md. Acts of 1973 Natural Res. Art., Ann. Code of Md., Section 1–301 *et seq.* (1974 Volume) as amended by Ch. 129 of the Md. Acts of 1975.	"Revised Guidelines for Implementation of the Maryland Environmental Policy Act," issued by the Secretary of the Department of Natural Resources, June 15, 1974.	Joseph Knapp, Administrator, Clearing House Review, Department of Natural Resources, Tawes State Office Building, Annapolis, Md. 21401 (Phone: 301–269–3548).
Massachusetts		
Ch. 747, Acts of 1977, Mass. Gen. Laws; Ch. 30, Section 61, 62 a-h.	Massachusetts Environmental Protection Act (MEPA) regulations, Massachusetts Register 142 (January 25, 1979), 301 CMR 10.00.	Samuel G. Mygatt, Director, MEPA Programs, Executive Office of Environmental Affairs, 100 Cambridge Street, Room 2000, Boston, Mass. 02202 (Phone: 617–727–5830).

Minnesota		
Minnesota Environmental Policy Act of 1973, Ch. 412, Laws of 1973, Minn. Stat. Ann. Ch. 116D (Cum. Supp. 1974).	"Rules and Regulations for Environmental Impact Statements," issued by the Minnesota Environmental Quality Council on April 4, 1974, as amended February 13, 1977.	Joe Sizer, Director, Environmental Planning, Environmental Quality Council, Capital Square Building, 550 Cedar Street, St. Paul, Minn. 55101 (Phone: 612–296–2712).
Montana		
Montana Environmental Policy Act of 1971, Title 75, Ch. 1, Mont. Code Ann. (MCA).	Montana Environmental Quality Council, "Revised Guidelines for Environmental Impact Statements Required by the Montana Environmental Policy Act of 1971," issued September 19, 1975 (under revision).	Ron Fenecs, Staff Attorney, Montana Environmental Quality Council, Capitol Station, Helena, Mont. 59601 (Phone: 406–449–3742).
New York		
New York State Environmental Quality Review Act, Art. 8, New York State Environmental Conservation Law, effective June 1, 1976, as amended and added by Section 8–0117 (May 28, 1976), as amended by Ch. 228 of 1976 Session laws, Ch. 252 of 1977 Session laws, Ch. 460 of 1978 Session laws.	6 N.Y.C.R.R., Part 617, effective November 1, 1978.	Jerome W. Jensen, CEQRA Coordinator, New York State Department of Environmental Conservation, 50 Wolf Road, Albany, N.Y. 12233 (Phone: 518–457–2224).
North Carolina		
North Carolina Environmental Policy Act of 1971 (1971, c. 1203, s.1), N.C. Gen. Stat. Ch. 113A (Cum. Supp. 1973).	North Carolina Department of Administration, "Guidelines for the Implementation of the Environmental Policy Act of 1971," issued February 18, 1972, updated March 1, 1975.	A. F. McRorie, Director, Division of Management, Dept. of Natural Resources and Community Development, P.O. Box 27687, Raleigh, N.C. 27611 (Phone: 919–733–7015)
South Dakota		
South Dakota Environmental Policy Act, SL 1974, Ch. 245 (approved March 2, 1974), S.D. Comp. Laws 1967, Ch. 11 1A (Supp. 1974).	Department of Environmental Protection, 1974 Informal Guidelines.	Warren Neufeld, Secretary, South Dakota Department of Water and Natural Resources, Foss Building, Pierre, S.D. 57501 (Phone: 605–773–3151).

Table 10–3 (continued)

States With Comprehensive Statutory Requirements—Continued

Source	Guidelines	State Contact
Virginia		
Virginia Environmental Quality Act of 1973, Ch. 384, Laws of 1973 (approved March 15, 1973) and Ch. 774, Laws of 1972, Va. Code Ann. Sections 10–17.107 through 10–17.112 and 10–177 through 10–186 (Supp. 1973), as amended by Ch. 354, Laws of 1974 (approved April 4, 1974), Va. Code Ann. Section 2.1–51.9, Section 10.181, Section 10.183, and Section 10.185, as amended by Ch. 404, Acts of Assembly, 1977.	*Procedures Manual for Environmental Impact Statements in the Commonwealth of Virginia*, issued by the Council on the Environment (December 1973; revised June 1978).	Reginald Wallace, Environmental Impact Statement Coordinator, Governor's Office, Council on the Environment, Eighth Street Office Building, Richmond, Va. 23219 (Phone: 804–786–4500).
Washington		
State Environmental Policy Act of 1971, Rev. Code Wash. Ch. 43.21C (Supp. 1973), as amended by Sub. Senate Bill 3277, Ch. 179, Laws of 1974 (May 5, 1974).	"Guidelines for Implementation of the State Environmental Policy Act of 1971," prepared by the Department of Ecology, as revised by "State Environmental Policy Act Guidelines" (WAC 197–10) issued by the Council on Environmental Policy, January 16, 1976, revised by Department of Ecology, January 21, 1978.	Tom Elwell, Environmental Review Section, Office of Comprehensive Programs, State of Washington, Department of Ecology, Olympia, Wa. 98504 (Phone: 206–753–6890).
Wisconsin		
Wisconsin Environmental Policy Act of 1971, Ch. 274, Laws of 1971, adding Wisc. Stat. Ann. Ch. 1 Section 1.11 *et seq.* (Cum. Supp. 1974–1975), as amended by Ch. 204, Laws of 1973.	"Revised Guidelines for the Implementation of the Wisconsin Environmental Policy Act," issued by the Governor's Executive Order No. 26 (February 1976) (under revision).	Caryl Terrell, State WEPA Coordinator, Wisconsin Citizen's Environmental Council, Rm. 415, 110 East Main St., Madison, Wisc. 53702 (Phone: 608–266–9338).

Puerto Rico		
Puerto Rico Environmental Policy Act, 12 Laws P.R. Ann. Section 1121, *et seq.* (1970), as amended Art. 11 § 24 (July 10, 1978).	"Guidelines for the Preparation, Evaluation, and Use of Environmental Impact Statements," issued by the Environmental Quality Board on December 19, 1972.	Roberto Rexach, Executive Director, Environmental Quality Board, 1550 Ponce de Leon Avenue, 4th Floor, Santurce, P.R. 19910 (Phone: 809–725–5140).
States With Comprehensive Executive or Administrative Orders		
Michigan		
Michigan Executive Directive 1971–10, as superseded by Michigan Executive Order 1973–9, as superseded by Michigan Executive Order 1974–4 (May 1974).	Interim Guidelines, prepared by the Environmental Review Board and issued June 24, 1974. Revised guidelines were adopted in November 1975.	Boyd Kinzley, Executive Secretary, Environmental Review Board, Department of Management and Budget, Lansing, Mich. 48913 (Phone: 517–373–6491).
New Jersey		
New Jersey Executive Order No. 53 (October 15, 1973).	"Guidelines for the Preparation of an Environmental Impact Statement," issued by the Office of the Commissioner, Department of Environmental Protection, in 1973 and updated in February 1974.	Lawrence Schmidt, Chief, Office of Environmental Review, Department of Environmental Protection, P.O. Box 1390, Trenton, N.J. 08625 (Phone: 609–292–2662).
Texas		
Policy for the Environment, adopted by the Interagency Council on Natural Resources and the Environment on March 7, 1972, and published in "Environment for Tomorrow: The Texas Response," subsequently updated by "The Environment Policy—Guidelines and Procedures for Processing EISs," developed and adopted by the Interagency Council on Natural Resources and the Environment, published November 1975.		Paul T. Wrotenbery, Director, Governor's Budget and Planning Office, Executive Office Building, 411 W. 13th Street, Austin, Tex. 78701 (Phone: 512–475–6156).
Utah		
State of Utah Executive Order, August 27, 1974.		William C. Quigley, Assistant Attorney General, State Capitol Building, Office of the Attorney General, Salt Lake City, Utah 84114 (Phone: 801–533–7643).

Table 10–3 (continued)

States With Special or Limited EIS Requirements

Source	Guidelines	State Contact
Arizona		
Game and Fish Commission Policy of July 2, 1971.	Memorandum by the Arizona Game and Fish Commission, "Requirements for Environmental Impact Statements," issued June 9, 1971.	Robert D. Curtis, Chief, Wildlife Planning and Development Division, Arizona Game and Fish Commission, 2222 W. Greenway Rd., Phoenix, Ariz. 85023 (Phone: 602–942–3000).
Delaware		
a) Delaware Coastal Zone Act, Ch. 175, Vol. 58, Laws of Del. (June 28, 1971), adding Del. Code Ann. Section 7001 *et seq.* (Supp. 1973), and b) Delaware Wetlands Law of 1973, adding 7 Del.Code Ann. Ch. 66 (Supp. 1973).	a) Del. Code Ann. Ch. 66, Section 6604 (Supp. 1973), and "Permit Application Instructions and Forms and Information Material on Required Procedures for the Coastal Zone Act," prepared and published by the Delaware State Planning Office (effective July 1, 1977); this office will be known as the Delaware Office of Management, Budget, and Planning, and b) "Department of Natural Resources and Environmental Control, Wetlands Regulations," adopted pursuant to Section 6607 of the Wetlands Act, effective December 23, 1976.	a) For the Coastal Zone Act—David Hugg, Manager, Coastal Zone Program, Delaware Office of Management, Budget, and Planing, Dover, Del. 19901 (Phone: 302–678–4271). b) For the Wetlands Act—William Moyer, Wetlands Manager, Department of Natural Resources and Environmental Control, Division of Environmental Control, Dover, Del. 19901 (Phone: 302–678–4761).
Georgia		
Ga. L. 1972–179 (March 10, 1972), Ga. Code Ann. Ch. 95A–1, Section 241(e)(1) (1973).	*Policy and Procedures Manual: State Tollway Authority*, prepared by Georgia's Tollway Administrator's Office in May, 1972 and revised in February, 1973.	Robert L. Austin, State Location Engineer, Division of Preconstruction, Department of Transportation, 2 Capitol Square, Atlanta, Ga. 30334 (Phone: 404–656–5312).

Kentucky		
Ch. 278.025 Ky. Rev. Stats (April 1, 1979) (requires statement of environmental compatibility before a power plant may be built.)	None.	Office of Policy and Program Analysis, Kentucky Department for Natural Resources and Environmental Protection, Capital Plaza Tower, Frankfort, Ky. 40601 (Phone: 502–564–7320).
Mississippi		
Title 49, Chapter 27, Mississippi Code of 1972, Section 49–27:1–49–27:69, amended in 1974 to include 49–27–7(s), relating to Wetlands.	Rules and Regulations written by the Mississippi Marine Resources Council, July 10, 1973, revised April 15, 1975 (under revision).	Joe Gill, Jr., Marine Projects Manager, Mississippi Marine Resources Council, P.O. Drawer 959, Long Beach, Miss. 39560 (Phone: 601–864–4602).
Nebraska		
Nebraska Department of Roads, *Department of Roads Action Plan* (1973), as revised by the *State of Nebraska Environmental Action Plan,* prepared by the Nebraska Department of Roads and approved by the Federal Highway Administration, June 24, 1975.		Mark Glaess, Acting Comprehensive Planning Coordinator, Office of Planning and Programming, Box 94601, State Capital, Lincoln, Nebr. 68509 (Phone: 402–471–2414).
Nevada		
Ch. 311, Laws of 1971, 58 N.R.S. Ch. 704 (1971).	No guidelines have been issued.	Hardy Heber, Public Service Commission, Capitol Complex, Carson City, Nev. 89710 (Phone: 702–885–4180).
New Jersey		
a) Coastal Area Facility Review Act, P.L. 1973, Ch. 185 (approved June 20, 1973), N.J.S.A. 13: 19–1 *et seq.* (Cum. Supp. 1974–1975). b) The New Jersey Wetlands Act of 1970, Ch. 272, Laws of 1970, N.J.S.A. 13:9A-1 *et seq.* (Cum. Supp. 1974–1975). c) Waterfront Development Permit Program, N.J.S.A. 12:5–3.	a) "Procedural Rules for the Administration of theCoastal Area Facility Review Act," prepared by the Department of Environmental Protection in 1974 and adopted April 1, 1977, and b) "New Jersey Wetlands Order: Basis and Background," issued by the New Jersey Department of Environmental Protection, April 1972, "Procedural Rules and Regulations to	a) David N. Kinsey, Chief, Office of Coastal Zone Management, New Jersey Department of Environmental Protection, P.O. Box 1889, Trenton, N.J. 08625 (Phone: 609–292–8262), and b) Thomas F. Hampton, Supervisor, Office of Wetlands Management, Division of Marine Services, Department of Environmental Protection, P.O. Box 1889, Trenton, N.J. 08625 (Phone: 609–292–8202).

Table 10–3 (continued)

States With Special or Limited EIS Requirements		
Source	**Guidelines**	**State Contact**
New Jersey—(Continued)	Implement the Wetlands Order," N.J.A.C. 7A-1 *et seq.*, adopted September 2, 1976. Rules on Coastal Resource and Development Policies, N.J.A.C. 7:7E-1.1 *et seq.*, Sept. 28, 1978 (applies to all).	
Rhode Island		
Section 10–20–8B of General Laws of R.I. (1978) Environmental Rights Act.	None.	R. Daniel Prentiss, Chief Legal Counsel, Office of Environmental Management, 83 Park St., Providence, R.I. 02903. (Phone: 401–277–2771).

City NEPA's		
Source	**Guidelines**	**City Contact**
Bowie, Maryland		
The Bowie, Maryland, Environmental Policy and Impact Statement Ordinance, passed by the City Council of Bowie, Maryland on May 3, 1971, and Ordinance 0–2–73 of the City Council of Bowie, Maryland, Declaring an Environmental Policy and Providing for Environmental Impact Statements, passed July 16, 1973, and Ordinance 0–14–76, Changing Notification and Referral Requirements under the Ordinance, passed September 8, 1976.		Glen Garber, Planning Director, Office of Planning and Community Development, City Hall, Bowie, Md. 20715 (Phone: 301–262–6200).
New York City		
Executive Order No. 91, June 1, 1977. New York City is currently working on a replacement policy which will incorporate the Executive Order and the requirements of the New York State Law. This order is being amended to conform with CEQRA amendment of November 1978.	A "City Environmental Policy Executive Order Environmental Information Form" is utilized for environmental analysis. The Information Form was prepared by the City of New York Environmental Protection Administration in 1973.	Francis Caroll, Director, Office of Environmental Impact, New York City Department of Environmental Protection, Room 2344, Municipal Building, New York, N.Y. 10007 (Phone: 212–566–4107).

REFERENCES

1. 42 U.S.C. § 4321 *et seq.* (1976).
2. *See* Council on Environmental Quality, *Environmental Quality—1978: The Ninth Annual Report of the Council on Environmental Quality* (Washington, D.C.: U.S. Government Printing Office, 1978) pp. 401–402 (summarizing testimony at June 1977 public hearings on the NEPA process and public comments on draft NEPA regulations).
3. Executive Order No. 11991, 3 C.F.R. 123 (1978).
4. 43 Fed. Reg. 24230 (1978).
5. 43 Fed. Reg. 55978 (1978) (to be codified in 40 C.F.R. 1500–1508). All references to the NEPA regulations will be cited to the section in which the material appears in the Code of Federal Regulations.
6. *Id.* § 1506.12. For programs administered under § 102(2)(D) of NEPA (concerning federal aid highways) and under § 102(h) of the Housing and Community Development Act of 1974 (community development block grants), the regulations become effective on November 30, 1979.
7. *Id.* § 1507.3.
8. 40 C.F.R. § 1501.7.
9. *Id.* § 1505.2.
10. *Id.* § 1502.
11. *Id.* § 1502.7.
12. *Id.* § 1502.20.
13. 44 Fed. Reg. 43115 (1979).
14. 40 C.F.R. § 1506.5.
15. 16 U.S.C. § 661 *et seq.* (1976).
16. 16 U.S.C. § 1536 *et seq.* (1976).
17. 16 U.S.C. § 470 *et seq.* (1976).
18. 40 C.F.R. § 1501.2.
19. *Id.* § 1501.7.
20. *Id.* § 1501.6.
21. *Id.* § 1502.25(a).
22. *Id.* § 1502.25(b).
23. *Id.* § 1501.2(d).
24. *Id.* § 1502.5(b).
25. *Id.* § 1501.8.
26. *Id.* § 1503.2.
27. *Id.* § 1503.3(d).
28. *Id.* § 1506.3(c).
29. NEPA Sec. 102(2)(C), 42 U.S.C. § 4332(2)(C) (1976).
30. 40 C.F.R. § 1506.8.
31. 16 U.S.C. § 1271 *et seq.* (1976).
32. 16 U.S.C. § 1131 *et seq.* (1976).
33. 40 C.F.R. § 1506.2.
34. NEPA Sec. 102(2)(F), 42 U.S.C. § 4332(2)(F) (1976).
35. *Sierra Club* v. *Adams,* 578 F.2d 389 (D.C.Cir. 1978) (assuming without deciding that the Department of Transportation's plan to construct a highway in Panama is subject to NEPA); *NORML* v. *Department of State,* 452 F. Supp. 1226 (D.D.C. 1978) (assuming without deciding that the Department of State herbicide spraying program in Mexico is subject to NEPA).
36. Executive Order No. 12114, 44 Fed. Reg. 1957 (1979).
37. *Id.* § 2–3(a).
38. *Id.* § 2–3(b).
39. *Id.* § 2–3(c)(2) at 1958.
40. *Id.* § 2–3(c)(1).
41. *Id.* § 2–3(d).
42. *Id.* § 2–1 at 1957.
43. *Id.* § 2–4(c) at 1958.

44. 47 U.S.L.W. 4676 (1979).
45. *Sierra Club* v. *Andrus,* 581 F.2d 895, 903 (1978).
46. 9 Envir. L. Rep. 65618 (1979).
47. *Ibid.*
48. 43 Fed. Reg. 55989 (1978).
49. 40 C.F.R. § 1508.17.
50. *Andrus* v. *Sierra Club,* 47 U.S.L.W. 4676, 4679 (1979).
51. *Ibid.*
52. *Ibid.*
53. *Id.* at 5680.
54. 40 C.F.R. Sec. 1502.1.
55. *Id.* § 1502.5.
56. *Id.* § 1508.11.
57. *Id.* § 1508.18.
58. 47 U.S.L.W. at 4677, note 1.
59. *Id.* at 4677.
60. 582 F.2d 77 (1st Cir. 1978).
61. *Id.* at 85.
62. *Union Oil Co.* v. *Morton,* 512 F.2d 743, 749 (9th Cir. 1975), and *Gulf Oil Corp.* v. *Morton,* 493 F.2d 141, 145 (9th Cir. 1973) (NEPA supplements the Secretary of Interior's authority to issue environmental regulations for drilling in the Outer Continental Shelf); *Zabel* v. *Tabb,* 430 F.2d 199, 214 (5th Cir. 1970) *cert. denied,* 401 U.S. 910 (1971) (NEPA is authority for the Army Corps of Engineers to deny a dredge and fill permit in order to protect the environmental quality of wetlands); *Environmental Defense Fund, Inc.* v. *Matthews,* 410 F.Supp. 336, 338 (D.D.C. 1976) (NEPA supplements FDA's existing authority to permit it to act on environmental consequences).
63. 462 F.Supp. 1155 (D. Alaska 1978).
64. *Defenders of Wildlife* v. *Andrus,* 9 ERC 2111 (D.D.C. 1978).
65. *Alaska* v. *Andrus,* 429 F. Supp. 958 (D. Alaska 1977).
66. 9 Envir. L. Reptr. 20137 (Feb. 22, 1979).
67. *Defenders of Wildlife* v. *Andrus,* Nos. 77–1611 and 78–1248 (filed March 16, 1979).
68. *Defenders of Wildlife* v. *Andrus,* Civ. A. No. 79–800 (filed March 23, 1979). CEQ's NEPA regulations, which were not in effect at the time of these decisions, also address this issue. Sec. 1508.18.
69. 16 U.S.C. Sec. 470 *et seq.* (1976).
70. 16 U.S.C. Sec. 1536 *et seq.* (1976).
71. 16 U.S.C. Sec. 661 *et seq.* (1976).
72. *Environmental Defense Fund, Inc.* v. *Froehlke* (Cache River), 473 F.2d 346 (8th Cir. 1972), *Cape Henry Bird Club* v. *Laird,* 359 F.Supp. 404 (W.D.Va. 1973), *aff'd* 484 F.2d 453 (4th Cir. 1973); *Environmental Defense Fund, Inc.* v. *Corps of Engineers* (Gillham Dam), 325 F. Supp. 749 (E.D. Ark. 1971).
73. *Environmental Defense Fund, Inc.* v. *Corps of Engineers* (Tennessee-Tombigbee), 492 F.2d 1123 (5th Cir. 1974); *St. Joseph Historical Society* v. *Land Clearance for Redevelopment Authority,* 366 F.Supp. 605 (W.D. Mo. 1973).
74. See *Stop H–3 Association* v. *Coleman,* 533 F.2d 434 (9th Cir.), cert. denied, 429 U.S. 999 (1976); *Brooks* v. *Coleman,* 518 F.2d 17 (9th Cir. 1975); *Arlington Coalition on Transportation* v. *Volpe,* 458 F.2d 1323 (4th Cir.), *cert. denied* 409 U.S. 1000 (1972); *Ely* v. *Velde,* 451 F.2d 1130 (4th Cir. 1971); *Named Individual Members of San Antonio Conservation Society* v. *Texas Highway Department,* 446 F.2d 1013 (5th Cir.) *cert. denied,* 406 U.S. 933 (1971); *Zabel* v. *Tabb,* 430 F.2d 199 (5th Cir.), *cert. denied,* 401 U.S. 910 (1970); *Waterbury Action to Conserve Our Heritage* v. *Harris,* F.Supp. (D.Con. 1978); *Hall County Historical Society* v. *Georgia Department of Transportation,* 447 F.Supp.

741 (N.D.Ga. 1978); *National Wildlife Federation* v. *Andrus,* 440 F.Supp. 1245 (D.D.C. 1977); *Inman Park Restoration, Inc.* v. *Urban Mass Transportation Administration,* 414 F.Supp. 99 (N.D. Ga., 1975), *aff'd.,* 576 F.2d 573 (5th Cir. 1978); *Thompson* v. *Fugate,* 347 F.Supp. 120 (E.D. Va. 1972); *Akers* v. *Resor,* 339 F.Supp. 1375 (W.D. Tenn. 1972). See also Environmental Law Institute, Federal Environmental Law 556–557 (1974).

75. 40 C.F.R. Sec. 1502.25.

76. Even where the Court finds that the agency has violated NEPA, the Court is not mandated to issue a preliminary injunction.

77. Particularly laws designed to control pollution such as the Toxic Substances Control Act, 15 U.S.C. § 2601 *et seq.* (1976); the Federal Water Pollution Control Act, 33 U.S.C. § 1251 *et seq.* (1976); the Marine Protection, Research, and Sanctuaries Act, 33 U.S.C. § 1401 *et seq.* (1976); the Safe Drinking Water Act, 42 U.S.C. § 300(f) *et seq.* (1976); the Clean Air Act, 42 U.S.C. § 1857 (1976); the Noise Control Act, 42 U.S.C. § 4901 *et seq.* (1976); and the Resource Conservation and Recovery Act, 42 U.S.C. § 6901 *et seq.* (1976).

CHAPTER 11

THE GLOBAL ENVIRONMENT

> There are mountains in Attica which can keep nothing but bees, but which were clothed not so long ago with fine trees, producing timber suitable for roofing the largest buildings. The roofs hewn from this timber are still in existence. There were also many lofty cultivated trees, while the country produced bountiful pastures for cattle. The annual supply of rainfall was not then lost, as it is at present, through being allowed to flow over a denuded surface to the sea. It was received by the country in all its abundance, stored in impervious potter's earth, and so was able to discharge the drainage of the hills into the hollows in the form of springs or rivers with an abundant volume and wide distribution. The shrines that survive to the present day on the extinct water supplies are evidence for the correctness of my hypothesis.

Thus Plato described the recently destroyed mountainous forests of Greece about 400 years before the Christian era began. Today, most of the old Mediterranean forest—the lofty cedars of Lebanon, the hilly groves of the Peloponnesus and southern Italy—are gone. The land that was once "clothed with fine trees" is in a stable state of complete erosion.[1]

Dry forests of the Mediterranean type—open woodland with mixed trees and grasslands—are still threatened today in many parts of the world. But tropical moist forests—the "jungle," symbol to many of unquenchable fertility—are in equal danger. The rapid extensive loss of forests throughout the tropical world has the widest implications for the "quality of mankind's world environment."[2]

Forest conditions are inseparably linked with land and water quality, which in turn immediately affect human life; with preservation of plant and animal species; with local and regional—possibly even global—climate changes. These interrelated effects link various elements of the biosphere and cross the political boundaries of many nations, affecting even the earth as a whole.

This chapter begins by describing the current intense international concern over the loss of world forests, especially in the tropics and subtropics, and the stirring of world response to the problem. The chapter then notes international efforts to protect other resources

important to many nations or all humankind, such as the great whales that traverse the oceans and the wild animals that cross national boundaries.

Just as the ecologically sound management of the world's flora and fauna requires attention and cooperative effort by many nations, so too do problems related to the atmosphere and oceans. The possibility that rising concentrations of carbon dioxide in the atmosphere may cause important changes in the global climate has aroused keen scientific interest and controversy. An international scientific program to improve knowledge of the world climate, including human influences upon it, is described in this chapter. Also discussed are oil spills in the oceans and multilateral efforts to control ocean disposal of hazardous wastes, in particular radioactive wastes.

An important international meeting this year on broad environmental issues was the second ministerial level meeting of the Environment Committee of the Organization for Economic Cooperation and Development (OECD). Convening for the first time in 5 years, the environment ministers of the 24 OECD nations discussed issues of particular importance to this group of industrialized, relatively wealthy nations. One subject of special interest was the connection between the environment and economics. Studies from several countries indicated their environmental protection programs are yielding a broad range of benefits; they are consistent with economic objectives of growth, jobs, and control of inflation; and their costs are affordable.

An international consensus is growing on the importance of assessing environmental effects before taking action, to avoid ill-considered consequences to the environment and to serve as the basis for sound decisions. This chapter notes the efforts of nations to assess the environmental effects of their own proposed actions and to work cooperatively with other nations when the effects cross national boundaries. The chapter concludes with a brief look at world population issues.

FORESTS

TRENDS

Throughout the tropical world, forests are disappearing at alarming rates. Many examples—mostly from the world's poorer countries, which are disproportionately located in or near tropical latitudes—show the seriousness of the situation. Honduras, for example, has lost from 30 to 40 percent of its forest cover over the past 20 years; at current rates of depletion the country could be entirely denuded within two generations.[3] The lowland rain forests of the Philippines and Malaysia could be grossly disrupted if not eliminated as early as 1985.[4] In Haiti, the forests are virtually gone.[5]

The exact rate of tropical forest loss worldwide is not known for certain; the changes are too rapid and monitoring too scanty. A

Above, Haiti where the forests are virtually gone and regrowth is not occurring. Photographer: Kay Chernush. Below, Puerto Rico, still rich in forests. The Hicaco Valley forest shown here is second growth. Photographer: Frank Wadsworth.

United Nations estimate, based on observation in 13 countries, puts the net loss at 11 million hectares (27 million acres) per year—an area roughly the size of Virginia.[6] Estimates from U.S. government agencies, used in the comprehensive "Global 2000" study being sponsored by the Council on Environmental Quality (CEQ), the State Department, and other agencies, indicate the losses may be closer to 20 million hectares (50 million acres) per year.[7] If the latter estimate is correct, the world's closed forests—those with a canopy of trees covering the ground—would decline from 2.6 billion hectares today (one-fifth of the earth's land surface) to 2.1 billion hectares (one-sixth of the land surface) by the year 2000.[8] Estimates of the extent of world forests by regions are shown in Table 11–1.

The rate of destruction of drier open woodland is still more difficult to estimate than that of closed forest. However, the advance of deserts, which is closely linked to dry forest loss, was estimated for the United Nations Conference on Desertification in 1977 at 5 million hectares per year.[9] In the mid-1970s, the world's open woodlands were estimated to cover 1.6 billion hectares, or 12 percent of global land area, as shown in Table 11–1.

Virtually all this loss is taking place in or near the tropics. Environmental damage from deforestation in these areas can be extreme and can be a direct cause of suffering for tens of millions of people. For example, intensified ruinous flooding, which has followed denudation of mountain slopes in many countries throughout history, is occurring increasingly today in tropical watersheds.[10] When the trees are no longer there to hold the soil on steep slopes, the soils erode. Rivers fill with silt, and the land can no longer hold water, so that ground water in the watershed dries up while the danger of floods mounts. The 1978 flood of the Ganges—the worst in 100 years—cost the lives of 2,000 people in India, washed away 40,000 cattle, and inundated most of

Table 11–1

The World's Forest By Region, Mid-1970s

Region	Closed Forest (million hectares)	Closed Forest as Share of Land Area (percent)	Open Woodlands (million hectares)	Open Woodlands as Share of Land Area (percent)
Latin America	680	33	280	14
USSR	680	30	240	11
North America	470	25	176	9
Asia	410	15	100	4
Africa	190	6	640	21
Europe	138	28	37	8
Oceania	89	10	105	12
World total	2,657	20	1,578	12

Source: Erik Eckholm, *Planting for the Future: Forestry for Human Needs*, Worldwatch Paper 26 (Washington, D.C.: The Worldwatch Institute, 1979).

two provinces and at least $750 million of crops. The severity of the flood was attributed in part to deforestation of Himalayan hillsides.[11]

The soils and other conditions of tropical forests are quite unlike those of the temperate zone. In many places, the soil is so seriously degraded after deforestation that the original forest will not grow again, and the land cannot support crops or pasture for more than a few years. The severity of the degradation depends on terrain, temperature, patterns and amount of rainfall, and method of forest cutting and land management. With heavy tropical rains, for example, soil erosion is often severe; a downpour that may cause soil loss of only 1 ton per hectare per year on forested lands may cause as much as 100 tons per hectare per year on crop lands.[12]

In addition, many tropical soils hold only a very limited supply of nutrients. One ecologist has called tropical forests "a desert covered with trees." [13] The trees, other plants, and animals of the forest store and efficiently recycle nutrients.[14] When the forest cover is gone, the hot tropical sun bakes the soil and stops microbial activity; heavy tropical rainfall leaches the nutrients; and within 2 or 3 years the land is no longer worth cultivating.[15] If the destruction is not too great or widespread, the forest may regrow and the land recover, as it has for thousands of years following shifting cultivation, and as it may also do with good forest management. But where the cutting is extensive, the soils poor, and the conditions unfavorable, loss of forest—and, indeed, of the productive capacity of the soil—may be permanent. The land bakes and gullies and becomes infertile badlands. Changes such as these have occurred in numerous parts of the tropical world, including Nigeria, Zaire, and the Amazon Basin.[16]

There is another aspect of irreversibility to tropical forest loss. Tropical forests are enormously diverse. Whereas a European forest typically contains 5 or 10 species of tree per hectare (2.5 acres), a tropical moist forest usually has 100 to 150 different tree species—in addition to a rich diversity of other plants and animals.[17] At the same time, these species may be of very limited geographic distribution, and because they have no means of wide dispersal, once they are gone, there is no recolonization from outside. Ecologist Duncan Poore stated the matter this way: "If the forest is removed, that kind of forest and all the species it contains will disappear." [18]

The importance of this loss becomes obvious when one considers that tropical moist forests contain literally millions of plant and animal species.[19] Respect for nature or reluctance to interfere with productive natural systems may restrain human beings from actions that destroy the uncounted and unclassified but irreplaceable life forms of the tropical forest. Yet there are more practical human-centered reasons as well. It is estimated that one-quarter of the prescription drugs dispensed in the United States today are either derived directly from wild plants or are invented in the laboratory using chemical clues derived from wild species. (In Europe the proportion of pharmaceuticals derived from wild plants is higher—one-half in West

Germany, for example.[20]) Of the drugs based on wild species, perhaps as many as half come from tropical forests;[21] examples are rauwolfia, curare, quinine, and oral contraceptives (derived from yams).[22] The genetic resources of wild plants are also valuable for breeding new characteristics, such as disease or pest resistance, into food plants.[23] They may even supply new species that can be used to great advantage as food crops.[24]

Finally, there is serious concern among some scientists that destruction of forests may change the world's climate in ways highly unfavorable to man. Regional and local climate changes—higher temperatures and altered rainfall patterns—have been observed following extensive forest loss. Changes on a global scale are far more speculative, but could be very disruptive. Two kinds of effects are of interest. First, alterations in the global climate might result from changes in the earth's albedo, that is, the reflection of light and heat from the earth's surface, when light-absorbing forests are removed. The heat balance of the earth would change, producing consequent changes in wind and rainfall patterns.[25]

Second, tropical forests are a great storehouse of carbon; roughly half of the carbon in the earth's biomass is stored in forests, with more than half of that in the tropics.[26] With large net losses of these forests, the concentration of carbon dioxide (CO_2) in the atmosphere could

Tropical moist forests are enormously diverse, containing millions of plant and animal species. Photographer: Bluford Muir.

rise significantly, adding to the rising trend already present as the result of burning fossil fuels. As discussed in more detail below, there are differences of scientific opinion on the possible consequences, but a widely held theory is that increasing CO_2 concentrations will cause a warming of the earth, with possibly disruptive effects on world agriculture and coastal communities.[27]

CAUSES

The principal direct causes of tropical forest loss are clearing for agriculture, fuelwood gathering, and industrial timbering. But behind these immediate causes are more fundamental social and economic problems—lack of agricultural development, great inequalities in land tenure and income, rapidly growing populations, and rising unemployment.[28] One overriding factor is obvious—poverty. Most of the countries in or near the tropics are poor countries of the less developed world. Growing numbers of people, mostly poor and in dire need of more farmland and fuelwood, exert a continuing pressure on the environment and its forest resources. And the economic pressure for quick realization of income from forests and forestlands, at the expense of long-term conservation, is much greater for poor countries than for the wealthy.[29]

All of these factors leading to forest loss are complex, and some may be shifting in importance as deforestation accelerates. However, agriculture, both on a family scale and on a large scale, is still the major cause of forest loss, as it has been throughout history. Under favorable conditions, where agricultural yields are sustainable, this conversion of forest to farmland has often been a good and necessary land use choice. Yet many of the farms and pastures being carved out of tropical forest today are all too likely to fail in a few years when soil fertility is lost and the land eroded.[30]

In some places, the agriculture replacing tropical forests is changing rapidly in character. For example, in parts of Central and South America large-scale cattle ranching is growing at the expense of forests. In some cases, the change to grazing is not sustainable; but the international demand for beef is strong enough that it seems profitable to raise cattle even on poor soils that deteriorate rapidly and are abandoned after a few years.[31]

Traditional shifting cultivation in tropical forests is changing as well. Over the ages, shifting cultivators evolved a method of farming in harmony with the tropical forest environment: they slashed and burned a clearing, grew crops for a few years, then moved to another plot when soil fertility declined, leaving the former plot to lie fallow long enough for regrowth and restoration of nutrients. In more remote parts of South America, Africa, and Southeast Asia, this sustainable system is still followed. But the system breaks down where populations are growing rapidly, or forest area is reduced by the spread of logging activities on large plantations.

Some of the forest destruction attributed to traditional shifting cultivation is actually due to attempts at slash-and-burn farming by immigrant, landless people, forced into unfamiliar country by population growth, unemployment, or unequal land tenure.[32] Furthermore, slash-and-burn cultivation is not independent of other incursions into the forest. When industrial timber companies or road builders open vast tracts of virgin forests with huge machinery, bands of farmers inevitably follow.[33]

With rapid population growth, aggravated by constantly rising petroleum prices, demands for fuelwood are becoming more intense. In the open woodland of semiarid countries, such as Sahelian Africa, cutting for fuelwood is the prime cause for loss of trees and other vegetation.[34] Fuelwood is scarce and terribly expensive in cities (taking one-quarter of the income of working people in some countries such as Upper Volta and Niger).[35] By contrast, in 1973 the average U.S. family spent 6 percent of its income for all energy needs.[36] In the countryside people must spend more and more time searching for firewood farther from home and village. In India, for example, one of the family (usually a woman or child) typically spends 2 days a week gathering firewood.[37]

Industrial forestry is increasing rapidly, especially in Southeast Asia. For example, according to a United Nations report, of 40 million hectares suitable for timbering in Indonesia, 12.5 million are being exploited now, 4 million are under concession, and 10 million are being inventoried for future concessions. Two-thirds of the present concessions were granted in the past decade.[38] Not all of this forest is lost in the sense that nothing will grow again. Logging usually does not cause total denudation of the forest (although it may open the area to migrant farmers). However, loggers in tropical forests do customarily take the most valuable trees, and the removal of these selected trees usually does considerable damage to other trees, plants, and soils. Where cutting is extensive, the original forest with its enormous species diversity will not replenish itself. And the magnificent hardwoods now being felled in tropical forests are likely to be replaced by lesser species unless sound forest management practices are adopted.[39]

RESPONSES

Because the known and potential impacts of massive deforestation constitute an urgent environmental problem for the whole world, the United States is giving the matter serious continuing attention. In June 1978, the Department of State and the Agency for International Development (AID) sponsored a Strategy Conference on Tropical Deforestation.[40] Participants from government, academia, environmental organizations, and industry convened in Washington to discuss the causes and impacts of deforestation, and to identify areas for future study and action. The Conference concluded that accelerated loss of tropical forests is an extremely serious world

problem, and called for a coordinated attack to protect these "undervalued and probably irreplaceable resources" from virtual destruction by the early part of the next century.[41] The Conference also concluded:

- Better information on tropical forest loss is essential;
- Forestry planning should receive the same level of attention as planning for agriculture, water resources, and mining;
- Education and training of forest managers throughout the tropical world should be improved; and
- The United States should lead by example in protecting and managing its own forests.

Following the Conference, in November 1978, an Interagency Task Force on Tropical Forests was formed, under State Department chairmanship, to develop recommendations for U.S. goals, strategies, and programs.

AID is already providing assistance for several development projects that will benefit tropical forests by means of watershed protection, reforestation, and development of alternative energy sources.[42] Underway in Latin America are a $9 million natural resource conservation program in Costa Rica, a $4 million integrated agricultural development program in Haiti, and a $10 million watershed management project in Panama. AID plans to spend at least $20 to $30 million annually in agroforestry and forestry projects in Latin America and the Caribbean.

In Africa, AID is sponsoring reforestation projects in Mauritania (funded at $1.3 million) and Gambia ($400,000); village woodlot research in Mauritania and a fuelwood production project in Senegal ($1.4 million). Projects in Mali and Senegal are testing solar-powered cookers, dryers, hot water heaters, and irrigation pumps.

The International Development Cooperation Act of 1979,[43] passed by both Houses of Congress by midyear, gives AID an additional mandate to assist developing countries with projects for forest protection and alternative energy use. Title I of the Act recommends emphasis on "community woodlots, agroforestry, reforestation, protection of watershed forests, and more effective forest management."[44] The Act also authorizes assistance for "research, development, and implementation of small-scale, decentralized renewable energy sources for rural areas,"[45] which will help alleviate demands on tropical forests for fuelwood.

The United States also brought the deforestation issue to international attention. In May 1979, the Governing Council of the United Nations Environment Programme (UNEP) adopted a resolution "to develop proposals for an integrated programme of activities for conservation and wise utilization of tropical forests."[46] At a meeting scheduled for February 1980, UNEP will work with experts from other U.N. organizations and national governments, and with other interested parties, to set tasks and divide responsibilities. The

Farmers in Pakistan are planting chir pines to reforest steep slopes. They are paid with food by the World Food Program. Landowners are given the trees and may cut grass from the planted slopes, but must keep livestock from grazing the replanted areas. Photographer: T. R. Mahoney.

group will report on its program and plans to the UNEP Governing Council in 1980.

Recognizing the increasing urgency of the problem of forest loss, the World Bank has altered its policy for forestry loans. The Bank announced in 1978 that instead of supporting only industrial forestry projects, it would also support environmentally protective forestry, rural development forestry (for example, establishment of village woodlots for fuelwood), and institution-building projects that emphasize education and research in forestry and agroforestry.[47]

LEADING BY EXAMPLE

The United States has a direct interest and responsibility in the tropical forests of Panama. Rapid deforestation in the tributary watersheds of the Panama Canal Zone is one of the complex of causes leading to lowered water levels in the canal system. If current trends continue, by the year 2000 the Republic of Panama might take over from the United States a "worthless ditch."[48] Panama and the United States are aware of the danger and are planning cooperative action to restore and stabilize the capacity of the canal.

In May 1977, normal ship traffic through the canal had to be halted, with some ships transferring cargo to overland carriage across

the isthmus and others going around Cape Horn, because water levels were too low for full operation. The incident made it clear that despite Panama's normally abundant annual rainfall, water supplies to the canal system can no longer be taken for granted.

Water from the canal system is being withdrawn to generate electric power, to serve cities in the Canal Zone, and to operate the canal itself. At the same time, deforestation in the tributary watersheds of the Canal Zone has greatly affected water flows to the system, reducing natural storage capacity. Since 1952, when 85 percent of the canal's tributary watersheds were covered with their original dense rain forest, 250,000 acres (35 percent) of the forest have been lost—burned for crop or pasture land. Should there be another serious drought, as there was in 1977, the combination of lost water storage capacity and heavy use of the fresh water of the system would lower water levels and interrupt use of the canal.

Without corrective action, the outlook for the future is worse than the present situation. Deforestation has caused sediment buildup to depths as great as 28 feet in parts of Lake Alajuela, a tributary reservoir for the canal. Already the lake has lost 5 percent of its active storage capacity. Forty percent could be gone by 2000 if current rates of forest loss continue.

To cope with the problem, AID is cooperating with Panama's Ministry of Agriculture in a $17 million, 5-year water management project. AID is making a $10 million loan to the project. Its main objectives are to strengthen the ability of the Panamanian government to manage renewable natural resources, to increase awareness of the importance of conservation, and to establish watershed management programs in the canal and two other priority watersheds.[49]

WHALE PROTECTION

At its July 1979 meeting, the International Whaling Commission (IWC) took a long step toward better protection of the world's whales. The IWC members voted to:

- Halt whaling from factory ships on the high seas (except for hunting of the relatively numerous minkes) and allow whaling only from coastal stations;
- Reduce killing of the commercially valuable but jeopardized sperm whales by more than three-quarters, with world quotas down from 9,360 sperm whales to 2,203; and
- Establish a whale sanctuary in most of the Indian Ocean where no hunting of any of the great whales will be allowed for 10 years.

The IWC moratorium on factory-ship whaling is to last indefinitely until international conservation measures are adequate to insure the whales' survival.

The overall quota for all species of whale was reduced from 19,526 to 15,654. The quota for minke whales was raised from 9,173 to

12,004, following the recommendation of the IWC Scientific Committee, which found that stocks of this species are increasing.[50]

The IWC's ban on pelagic whaling was a response to proposals by the United States and other nations for a moratorium on all commercial whaling. Four years earlier, the IWC had adopted a new method of conservation and management of the world's whales, based on scientific advice and the collection of improved data. This method—the New Management Procedure—was a compromise. The United States had strongly urged a 10-year moratorium on commercial whaling and had won the near-unanimous support of the nations gathered at Stockholm in 1972 for the United Nations Conference on the Human Environment. But whaling nations just as strongly resisted the moratorium, and the IWC (which operates on the basis of a three-quarters majority) adopted an Australian proposal for "selective" moratoria. The Australian proposal involved setting catch quotas of zero for whale stocks found to be in serious trouble, on the basis of scientific analysis, and quotas for healthier stocks according to scientific concepts of sustainable yield.

Under the New Management Procedure, overall whale quotas have dropped every year, as shown in Table 11–2. But whether this is evidence of the success or failure of the New Management Procedure is a serious question. After 4 years, the United States was convinced that the IWC program to manage whales scientifically had demonstrated significant flaws. The data needed for scientific whale conservation were far from complete, analysis was difficult, and shortcomings in the New Management Procedure itself had led to continued taking of species that were in serious decline. In addition, the continued purchase of whale products by IWC members from nations that had neither joined the IWC nor observed its quotas tended to undermine the common effort. For example, although the Japanese

Table 11–2

Commercial Whaling Quotas International Whaling Commission, 1974–79

(number of animals)

Season	Species					
	Fin	Minke	Sei	Bryde's	Sperm	Totals
1974–75	1,300	7,000	4,000	• 2,000	23,000	37,300
1975–76	585	9,360	2,230	1,363	19,040	32,578
1976–77	455	11,924	1,995	1,000	12,676	28,050
1977–78	459	8,645	855	524	13,037	23,520
1978–79	455	9,173	84	454	9,360	19,526
1979–80	604	12,004	100	743	2,203	15,654

• Represents combined quota of 2,000 Sei and Bryde's whales in the North Pacific.

Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, *The United States and Whale Conservation*, October 1978, and unpublished information provided by the National Oceanic and Atmospheric Administration.

whale catch declined from 17,393 animals in 1972 to 9,247 in 1977, Japanese imports of whale meat from non-IWC members rose from 4,201 metric tons in 1972 to 10,432 in 1978, as shown in Table 11–3. On July 5, 1979, however, Japan instituted a ban on the import of whale meat from non-IWC countries.

Mindful of the flaws in the current system, the United States proposed that the IWC halt all commercial whaling until these conditions were satisfied: [51]

- The New Management Procedure is stengthened by adoption of a conservation principle that takes into account ecological influences and consequences, instead of relying on the less sophisticated concept of maximum sustainable yield;
- Population levels used in the New Management Procedure can be determined accurately enough to preserve whale stocks;
- IWC members no longer transfer whaling equipment to nonmembers;
- IWC members perform all the analyses and furnish all the data required by the Convention or the IWC Scientific Committee; and
- IWC members fund the work of the Commission adequately.

When the IWC adopted the ban on factory ship whaling for all species except the minkes, the conditions outlined above were included. Other nations besides the United States were strong proponents of a ban on commercial whaling. Australian Prime Minister Malcolm Fraser announced in April 1979 that Australia would end its own whaling operations, would oppose whaling internationally, and would ban the import of whale products.[52] While seeking an international ban, Australia would support greater emphasis on conservation and a more cautious approach to catch limits in the IWC. At the same time, Australia recommended that, in establishing a ban, IWC take into account special needs for subsistence catches or for use of whale meat for protein. The Australian position was based on an 8-month inquiry and report by a special commission headed by Sir Sydney Frost.[53]

Table 11–3

Japanese Imports of Whale Meat From Non-IWC Members

(metric tons)

	1971	1972	1973	1974	1975	1976	1977	1978
Imports	4,170	4,201	4,995	6,798	4,831	5,665	7,642	10,432
Percentage increase over 1971	—	1	20	63	16	36	83	150

Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, *The Moratorium Issue* (Washington, D.C.: U.S. Government Printing Office, 1979).

The International Whaling Commission has banned the killing of sperm whales from oceangoing factory ships.

Three whaling nations that had been taking whales in excess of IWC quotas (South Korea, Peru, and Chile) agreed to join the IWC in 1979. Another new member, joining in March 1979, was Seychelles, a nonwhaling nation. For the July IWC meeting, Seychelles proposed a 3-year moratorium on commercial taking of sperm whales, as well as other conservation measures.

WILDLIFE AND HABITAT PROTECTION

THE CONVENTION ON INTERNATIONAL TRADE IN ENDANGERED SPECIES OF WILD FAUNA AND FLORA

The Convention on International Trade in Endangered Species (CITES) treaty has been in effect for 4 years, and 51 nations have ratified it. The convention prohibits or very strictly limits trade in endangered species (those listed on Appendix I of the treaty), and regulates trade in those plants and animals that are in less immediate danger but are still threatened, or that closely resemble those classified as endangered (these plants and animals are listed on Appendix II of the treaty).

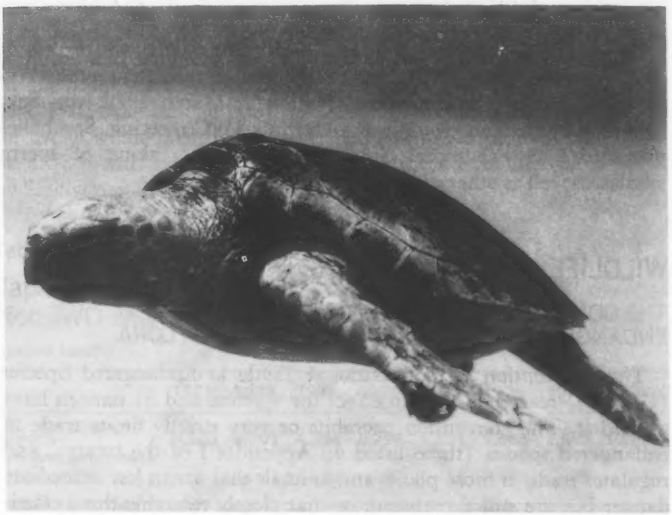
The discussions at the second meeting of the member nations, in San Jose, Costa Rica, in March 1979, indicate several encouraging developments.[54] The national agencies that are being established to deal with trade in endangered species are also building general scientific and management capabilities to protect wildlife species in many countries. Moreover, national systems of permits, inspections, and collection of required data on endangered plant and wildlife shipments are improving.

At the 1979 meeting, the parties made a detailed review of the species and groups listed in Appendixes I and II, examining the scientific justification for listings. In addition, protection for whales and dolphins was improved; all cetaceans not listed in Appendix I were put on Appendix II, either because of threatened status or because they are "look-alikes," impossible to distinguish in trade from products of endangered whale species.

Substantial progress has been made under CITES, but there are still issues to be resolved on coverage, identification, and enforcement. A major problem is to get the few remaining big wildlife buyers and suppliers to join and abide by the convention's terms. Among these are Japan, Italy, Mexico, and the East African countries (except Kenya, which is already a member).

WESTERN HEMISPHERE CONVENTION

The 1940 Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere has been ratified by most of the nations of the Americas but has yet to be put into effect. To help re-



The endangered loggerhead turtle, once subject to heavy commercial pressure, is now protected by treaty from international trade.

vitalize this broadly conceived, hemisphere-wide conservation treaty, the Organization of American States (OAS) has organized five technical meetings to make recommendations on major conservation issues in the hemisphere. Meetings on marine mammals, ecosystem conservation, training needs, and migratory animals have been completed. The fifth meeting, on legal aspects of implementing the convention, will be held in Washington, D.C., in December 1979. It is expected that this meeting will recommend a reconvening of the parties to the convention in 1981. The United States has offered to host this ministerial level meeting, which will consider actions needed to implement the convention.[55]

THE CONVENTION ON THE CONSERVATION OF MIGRATORY SPECIES OF WILD ANIMALS

In June 1979, a new Convention on the Conservation of Migratory Species of Wild Animals was concluded in Bonn, with the signature of 22 nations.[56] The convention provides a broad framework for conservation of all migratory species, with emphasis on those in particular need of protection. Under this umbrella agreement, nations are encouraged to negotiate regional or bilateral agreements on species protection. The convention has the potential to help close gaps in the national and international protection accorded migratory species. It could also help improve conservation abilities in areas of the world where such needs are just beginning to be acknowledged. It should prove valuable in establishing protection for birds migrating across the Mediterranean as well as migrating African animals.

Sixty-three nations participated in the conference; most of the 22 signing it were European and African. The United States proposed a number of amendments to the draft convention, many of which were adopted. However, the United States was still concerned about certain aspects of the convention: the inclusion of marine finfish and shellfish; possible effects on the present federal-state division of authority over wildlife; and the ambiguity of certain language relating to coastal states' jurisdication. This last issue may, however, be resolved in the current Law of the Sea negotiations. Because of these uncertainties, the United States did not sign the convention at Bonn, but left the question of signing for further consideration.

CARBON DIOXIDE IN THE ATMOSPHERE

The possibility of global climate change induced by an increase of carbon dioxide in the atmosphere is the subject of intense discussion and controversy among scientists. On the basis of historical records that show increasing CO_2 concentrations, and projections of future increases in fossil fuel combustion and deforestation, many scientists believe that the amount of CO_2 in the atmosphere could double over

the hundred years ending in the middle of the next century.[57] According to some estimates, the result could be a 2° to 3° Celsius rise in temperature in the middle latitudes, with larger increases in the upper, lower, and polar regions. These changes could conceivably affect the extent and stability of Greenland and Antarctic ice with consequent rising sea levels and inundation of low-lying coastal areas and changes in the productivity of ocean fisheries. Precipitation and growing seasons for crops could be greatly altered, possibly disrupting world agriculture; one result might be persistent drought in grain belts such as the midwestern United States. The effects on plants, animals, and human societies that might not readily adapt to the changes could be profound. On the other hand, some scientists believe countervailing factors—such as increased dust particles in the air, which reflect sunlight away from the earth and have a cooling effect—could offset the CO_2 "greenhouse" effect.[58] Conceivably, scientific proof of the warming of the earth might come after the time has passed when action could be taken to reverse the trend. "If we wait until there is absolute proof that the increase in CO_2 is causing a warming of the earth," says Dr. George Woodwell of Woods Hole Marine Biological Laboratory, "it will be 20 years too late to do anything about it."[59]

Recognizing that the CO_2 buildup is "potentially the most important environmental issue facing mankind," the U.S. Department of Energy is coordinating an interagency Carbon Dioxide Effects Research and Assessment Program. This broad research program is intended to improve predictions of the health, environmental, economic, social, and political costs and benefits of the increasing atmospheric concentrations of CO_2 and resulting effects, so that policy decisions on the future national and global uses of fossil fuels can be soundly based. The program will identify trends in atmospheric CO_2 concentrations, project effects on climate, and estimate the effects of such changes on the world environment. In the fifth and tenth years of the program, 1983 and 1988, comprehensive analysis reports will be issued on the estimated amounts and effects of atmospheric CO_2 concentrations.[60]

In February 1978, the World Climate Conference convened in Geneva to assess current knowledge of prospective climate changes and to identify gaps in scientific research, weather, climate services, and knowledge of effects on societies and environments. In May and June 1979, using the results of the World Climate Conference, the Eighth Congress of the World Meteorological Organization formulated a World Climate Program, which will consider the role of CO_2 in the climate system and assess its ultimate impact on human activities.[61] At the April and May 1979 meeting of the United Nations Environment Programme Governing Council, UNEP was authorized to participate in the World Climate Program's consideration of the CO_2 issue. UNEP will be particularly concerned with fostering and coordinating studies on the effects of human actions on climate changes and of climate change on human society.[62]

OCEANS

OCEAN DISPOSAL OF RADIOACTIVE WASTES

With increasing competing demands for decreasing land available for disposal of low-level radioactive waste, several more nations are looking toward the oceans as an alternative to land burial.

Beginning in 1967, ocean disposal of low- and intermediate-level radioactive waste by members of the Organization for Economic Cooperation and Development (OECD) has been conducted under the direct supervision of the OECD's Nuclear Energy Agency. In 1977, this supervision was formalized by the OECD Council, which established a Multilateral Consultation and Surveillance Mechanism for Sea Dumping of Radioactive Waste.[68] Countries participating in this Council Decision agreed to abide by its provisions.

The countries most active in disposal of radioactive wastes at sea have been Belgium, the Netherlands, Switzerland, and the United Kingdom, with the greatest share of the radioactive waste coming from the United Kingdom. Table 11–4 summarizes radioactive waste dumping between 1967 and 1977 in the primary approved site, located in the Northeast Atlantic, 500 nautical miles southwest of Ireland, at a depth greater than 4,000 meters. The table shows a trend toward increased levels of radioactivity, both in alpha and in beta-gamma radiation, in the wastes being dumped. (The substances emitting alpha radiation are the long-lived actinide isotopes; those emitting beta and gamma radiation have shorter half-lives.)

A broader international control over ocean disposal of nuclear waste is contained in the 1972 Convention on the Prevention of

Table 11–4

NEA/OECD Sea Disposal Operations

Year	Dumped Weight (metric tons)	Approximate Activity (curies)	
		Alpha (actinides)	Beta-Gamma (including tritium)
1967	10,840	250	7,600
1969	9,180	500	22,000
1971	3,970	630	11,200
1972	4,130	680	21,600
1973	4,350	740	12,600
1974	2,270	420	[a] 100,000
1975	4,460	780	[b] 60,500
1976	6,770	880	[c] 53,500
1977	5,605	958	[d] 68,277

[a] Tritium almost exclusively.
[b] Including about 30,000 curies of tritium.
[c] Including about 21,000 curies of tritium.
[d] Including 31,886 curies of tritium.

Source: Organization for Economic Cooperation and Development, *Activity Reports* of the European Nuclear Energy Agency, Nos. 9–13 (Paris: OECD, 1967–71); *Activity Reports* of the Nuclear Energy Agency, Nos. 1–6 (Paris: OECD/NEA, 1972–77).

Marine Pollution by Dumping of Wastes and Other Matter (London Ocean Dumping Convention), which entered into force in 1975.[64] The basic purpose of the convention is to prevent marine pollution. Its Annex I prohibits dumping at sea of high-level radioactive wastes. The International Atomic Energy Agency (IAEA) developed a definition of the high-level radioactive wastes that the convention bans from ocean disposal and recommended controls over the disposal of all other radioactive materials.[65]

Several significant issues have not yet been settled by the OECD/Nuclear Energy Agency or the IAEA and remain controversial. These include: the quantitative definition of high-level radioactive waste that may not be dumped at sea, and the environmental monitoring required; the extent to which the radioactive contents of dumped wastes must remain intact and isolated from the marine environment; the kind of environmental impact statement that might be required for present or potential ocean disposal sites; and methods for predicting, measuring, and assessing effects on man and the marine environment from ocean disposal of radioactive wastes.

Between 1946 and 1970, the United States disposed of low-level radioactive wastes in the ocean, using four major sites for most of the radioactive materials. Table 11–5 summarizes the activity at these sites.

The United States does not now dispose of any kind of radioactive wastes—low-level or high-level—in the oceans. U.S. dumping ceased in 1970, in accordance with recommendations in a CEQ Report to the President on Ocean Dumping.[66] The Marine Protection, Research, and Sanctuaries Act of 1972 (commonly called the Ocean Dumping Act) [67] prohibits the dumping of high-level radioactive wastes and radioactive war materials in the ocean. Under the act, the U.S. Environmental Protection Agency regulates the disposal of all other wastes in the oceans. EPA has so far issued no permits for ocean disposal of any nuclear wastes but has issued broad policy guidance requiring isolation and containment of radioactive wastes until they decay to innocuous levels.[68] The Nuclear Regulatory Commission has recommended further study of ocean disposal of low-level radioactive wastes.[69] And the Federal Interagency Task Force on Nuclear Waste Management in its March 1979 report to the President [70] mentioned as options to be explored ocean disposal in accordance with EPA requirements, and burial under the ocean floor.

OIL SPILLS

The worst oil spill in history began June 3, 1979, with the blowout of IXTOC No. 1, a well being drilled in the Bay of Campeche by PEMEX, Mexico's national oil company. Estimates of the oil spilled ranged from 10,000 to 30,000 barrels per day [71]—an indication of the enormous size of the field the well had tapped and the immense pressures contained in it. Efforts to plug the well were

Table 11–5

Primary U.S. Radioactive Waste Dumpsites

Site	Coordinates	Depth (m)	Distance from Land (km)	Years Dumpsite Used	Estimated Number of 55-Gallon Drums Dumped	Estimated Activity in Drums at Time of Packaging (Ci)
Atlantic	38°30′N 72°06′W	2800	190	1951–1956 1959–1962	14,300	*41,400
Atlantic	37°50′N 70°35′W	3800	320	1957–1959	14,500	2,100
Pacific						
Farallon Island (Subsite A)	37°38′N 123°08′W	900	60	1951–1953	3,500	1,100
Farallon Island (Subsite B)	37°37′N 123°17′W	1700	77	1946–1950 1954–1965	44,000	13,400

* This does not include the pressure vessel of the N/S Seawolf reactor with an estimated induced activity of 33,000 Ci.

Source: R.S. Dyer, "Environmental Surveys of Two Deep Sea Radioactive Disposal Sites Using Submersibles," *Symposium on Management of Radioactive Wastes from the Nuclear Fuel Cycle*, IAEA–SM–207/65 (Vienna, Austria: International Atomic Energy Agency, 1976).

unsuccessful, and drilling of two relief wells began. However, they were not expected to intercept IXTOC No. 1 and permit operations to stop the flow until late fall or early winter.

The United States offered assistance to the Mexican government for the cleanup operations, asked permission for U.S. scientists to cooperate with Mexican scientists in studying the spill, and suggested contingency plans to protect Kemp's Ridley turtles, an endangered species that were hatching on the Mexican coast north of Tampico. In late July, the Mexican authorities requested that the U.S. Coast Guard send its Open Water Containment Recovery System to help clean up the spill. Meanwhile, cleanup firms from around the world had been summoned to help collect the oil, but cleanup efforts were only partially successful at best. By the end of July, oil slicks had been carried 400 miles north and were near the Texas coast. The U.S. Coast Guard and Texas authorities prepared to try to protect the highly productive estuaries behind the string of barrier islands on the south Texas coast and to mitigate damage to beaches and the tourist industry.[72]

The worst oil spill before the Bay of Campeche blowout occurred when the oil tanker *Amoco Cadiz* went aground in the English Channel in March 1978. The tanker broke up in high seas, spilling its entire cargo of 216,000 tons of crude oil. Soon after the spill, U.S. and French oceanographic scientists agreed to conduct a cooperative 3-year research program on the short- and long-term ecological effects. A French national research program, particularly on oysters and fisheries, is being coordinated with the joint U.S.-French effort. The program is studying the chemical states of oil as it deteriorates and weathers; the effects of the spill on nearby estuaries; conditions in the bays of Morlaix and Lannion, which have large amounts of oil in the bottom sediments; microbiological degradation of the oil; and the effects on a particular salt marsh that was bulldozed after the spill and subsequently replanted. The Center for Ocean Management Studies of the University of Rhode Island, under contract to the National Oceanic and Atmospheric Administration, has begun a study of the economic effects of the spill, including cleanup costs, damage to fisheries and aquaculture, recreation and tourism, and secondary costs. The report is due in September 1980.[73]

OECD ENVIRONMENT MINISTERS MEETING

Convening in Paris in May 1979, the OECD environment ministers reported improved environmental protection over the past decade, at affordable cost. EPA Administrator Douglas Costle chaired the meeting and CEQ Chairman Charles Warren headed the U.S. delegation.

The environment ministers pointed to achievements in controlling pollution in fresh water bodies and air pollution in urban areas; reducing the flow of certain persistent chemicals into the environment; extending national and regional parks; and protecting and rehabilitating sites of social or cultural value.[74]

Hatchlings of Kemp's Ridley turtles, an endangered species, were airlifted away from a beach threatened by the Campeche Bay offshore oil spill. Photographer: Fred Mang, Jr.

The ministers pointed out that these improvements in environmental quality had generated significant benefits, in most cases without negative effects on the economy. They note that the short-term net employment effects have been positive; the impact on inflation has been on the whole moderate, averaging 0.1 to 0.3 percent per annum; and the effect on the rate of economic growth in the short run has been neutral, perhaps even slightly positive. Overall, expenditures by OECD countries on pollution abatement amounted to 1 to 2 percent of GNP. (Some studies indicate that damage from pollution has ranged between 3 and 5 percent of GNP.) Specific benefits have included lowered death rate and less illness, improved productivity in land and labor, technological innovation, and increased amenities. The minister also noted that in some sectors, such as energy, output has improved relative to resource consumption and emissions of pollutants. They concluded that in the long run environmental protection and economic development are not only compatible but interdependent and mutually reinforcing. They also requested that further studies on the social and economic benefits of environment policy be pursued in the framework of the OECD.

The ministers noted that environmental quality remains a source of concern in certain fields, such as the supply and quality of water including, in particular areas, drinking water. They also noted the adverse effect of the excessive use of fertilizers, the effect on ecosystems of the long-range transport of airborne pollutants, air pollution by recently recognized pollutants, increasing noise levels in some areas, the risk of accidents involving hazardous substances, and, in general, the growing evidence of linkage between environmental deterioration and human health.

In discussing specific problems, the ministers stressed energy and chemicals. They asked for more emphasis on energy conservation and development of new forms of energy sources. Recognizing that such sources may be several decades away, they asked for vigorous interim measures to control pollution due to energy production and consumption, with special attention to coal.

The ministers recognized the all-pervasive importance of chemicals in everyday life and the economic significance of the chemical industry, and stressed the need for anticipatory policies to control chemical pollution. They renewed their support for the OECD programs on control of chemical substances to protect the environment and human health and to harmonize policies, while avoiding undue negative economic effects and trade distortions.

The ministers foresaw the need to continue and strengthen policies to protect the environment in the 1980s. They agreed that environmental considerations must be integrated at an early stage in all major decisions likely to have significant effects on the environment, and that environmental assessment of projects is one means of achieving this.

Finally, the ministers stressed the need to improve information on the state of the environment and called for systematic monitoring and reporting.

BILATERAL ENVIRONMENTAL EFFORTS

CANADA

In November 1978, the United States and Canada renewed the Great Lakes Water Quality Agreement, originally signed in 1972.[75] The new agreement revises the water quality objectives of the 1972 agreement and brings them up to date. It calls for completion by 1982 of an inventory of toxic substances discharged into the Great Lakes. It decreases the allowable amounts of phosphorus in discharges from wastewater treatment plants into the Great Lakes, and it provides for the establishment of limited-use zones, in which certain water quality objectives will not apply, but in which there can be no discharges of toxic substances.

The United States and Canada also reached agreement on a number of potential transboundary problems. Still other problems remain to be worked out. Two new Canadian coalfired power plants aroused U.S. concern over possible effects on U.S. air and water quality.[76] Canada agreed to scale down its planned Atikokan plant in Ontario from 800 to 400 megawatts and to install the capability for scrubbers. The United States had been concerned about possible effects on the Boundary Waters Canoe Area in northern Minnesota. Another planned power plant, at Coronach, Saskatchewan, may affect both air and water quality in Montana's Poplar River. Possible mitigation is under discussion.

In the United States, the Garrison Diversion, a 250,000-acre irrigation project in North Dakota, poses a potential threat to Canadian lake and river fisheries. Although Congress has mandated further construction on this project, the Department of the Interior has announced that no work will be done on parts potentially affecting rivers flowing into Canada, unless there is assurance that the United States can meet its commitments under the Boundary Water Treaty of 1909.[77]

U.S. Secretary of State Vance and Canadian Minister for External Affairs Jamieson agreed in Ottawa in mid-November 1978 that the two governments should begin discussion of a bilateral agreement on transboundary air pollution. Representatives of the two countries agreed in mid-December 1978 to try to develop common principles that might be incorporated in such an agreement. The parties met again in mid-June 1979 to exchange draft principles.[78]

MEXICO

The range of United States and Mexican environmental interests in the border zone, and cooperative efforts to solve pressing and

emerging environmental problems, were highlighted during President Carter's visit to Mexico in February 1979. The two countries signed cooperative agreements to launch new programs to improve management of extensive arid and semiarid lands and to control desertification; to solve problems of housing and urban development; and to expand science and technology applications, including development of new crops for arid zones.[79] The 1978 Native Latex Commercialization Act,[80] which specifically calls for collaboration with Mexico on commercial development of the arid zone plant guayule as a rubber substitute, is one means by which the United States will implement the agreements.

The United States has had to deal with several serious water pollution problems that originated in Mexico. The International Boundary and Water Commision has tried to solve urgent border sanitation problems promptly and is also seeking permanent solutions to persistent problems. The Mexican government has taken emergency steps to halt public health hazards, and recommendations requested by the two presidents at their meeting in Mexico may lead to a permanent remedy.

EPA and its Mexican counterpart have begun specific activities to control border area pollution, including design of an early warning system on potential environmental problems, and improvement of data gathering and exchange.

Problems currently under bilateral discussion, besides the flow of untreated Mexican sewage into U.S. border communities, include air pollution issues, particularly in the San Diego/Tijuana and El Paso/Ciudad Juarez areas. Concern over lead particulate emissions from the ASARCO smelting plant in El Paso (now practically eliminated) has led to a cooperative program to test lead levels in children's blood in El Paso/Ciudad Juarez. A serious emerging problem is the depletion of underground water resources in some U.S. border regions due to expanded irrigation in both countries and complete use of surface waters.

Discussions are proceeding in the U.S.-Mexico Commission on Science and Technology Cooperation on possibilities for future cooperation in solar energy research and development, geothermal development, expansion of public health services, control of communicable diseases in border areas, saline water conversion, marine mammal protection, oil spill research and technology, and tropical deforestation.

PANAMA

In addition to the U.S.-Panama cooperative program to restore and protect the Canal Zone, described earlier in this chapter, the two countries are preparing to set up a Joint Environmental Commission. The Commission will recommend to the two governments measures to avoid or mitigate any adverse environmental effect related to implementation of the new Panama Canal treaties [81] after they come into effect on October 1, 1979.

The Department of State's environmental impact statement on the treaties signaled the importance of environmental protection to the operation of the Panama Canal.[82] It set forth the need to preserve the canal's watershed, its forests and wildlife, and called attention to other potential environmental problems related to implementation of the treaties.

OTHER BILATERAL ACTIVITIES

Cooperative exchanges with a number of countries, initiated throughout the 1970s, continued to have productive results. The U.S.-Japanese program, begun early in the decade and formalized in 1975, now includes 13 joint projects. Among the most active are projects on sewage treatment and management of bottom sediments containing toxic pollutants. Recently underway is a new program to exchange data on testing for toxicity of chemicals.[83]

The 7-year-old U.S.-U.S.S.R. agreement on cooperation in the field of environmental protection involves 41 projects (some more active than others) and the annual exchange of some 300 U.S. and Soviet scientists, engineers, and government officials. Subjects of joint projects have included transport of air pollutants, toxic accumulations in fresh water fish, water quality management, and environmental analysis. Conservation efforts continue under the U.S.-U.S.S.R. Convention Concerning the Conservation of Migratory Birds and Their Environment, [84] and a similar agreement covering Northern Pacific marine mammals has been proposed by the United States.

Environmental exchanges are also continuing between the United States, the Federal Republic of Germany, Poland, and Egypt. Cooperative programs between EPA and Polish specialists on disposal of wastes from coal mines and coalfired power plants are of particular interest. Among the several cooperative projects with Egypt is a study of the impacts of the Aswan Dam on hydrology, water quality, aquatic ecology, public health, agriculture, and Egyptian society. A new U.S.-Egyptian project will assess the environmental effects of industrial projects in the Red Sea.

ENVIRONMENTAL ASSESSMENT: INTERNATIONAL OUTLOOK

During the 1970s, a number of countries have followed the lead of the United States and have looked for ways to assess in advance environmental impacts of major actions. At the May 1979 ministerial-level meeting, the OECD Environment Committee recommended that its 24 members integrate comprehensive environmental assessment procedures into their government processes.[85]

Several developed countries have adopted environmental impact assessment procedures, in one form or another, in their planning and

decisionmaking: Australia, Canada, the Federal Republic of Germany, France, Japan, New Zealand, Sweden, and the United Kingdom. Among those considering legislation for environmental assessments are Ireland and the Netherlands.[86]

Developing nations are also finding environmental assessment a valuable tool for insuring that potential effects on natural and social systems are fully considered in development planning. Among those that are considering or have already introduced specific environmental assessment techniques into project planning are India, Malaysia, and the Philippines; and other nations are exploring the possibilities.[87]

Most of the environmental impact assessment efforts so far have concentrated on impacts within the jurisdictions of individual countries. But there are indications of increasing willingness to put into practice Principle 21 of the 1972 Stockholm Declaration, which says that nations have "the responsibility to ensure that activities within their jurisdictions or control do not cause damage to the environment of other states or of areas beyond the limits of national jurisdiction"—that is, the global commons.[88] An Executive Order on Environmental Effects Abroad of Major Federal Actions, signed by President Carter on January 4, 1979, follows the spirit of Principle 21.[89] (See Chapter 10 for details on this Executive order.) Since 1976, AID has included environmental assessments in its project evaluations. The Department of State and some other U.S. agencies have done likewise during the 1970s for many of the actions affecting other countries and the global commons.

Multinational organizations have also taken significant steps toward environmental assessment. The World Bank has begun to do environmental impact assessments in its project planning, while other multilateral development banks, such as the Inter-American Bank, are considering incorporating environmental assessment into their loan planning. The Commission of the European Communities is developing a draft directive on environmental impact assessment that is to be submitted to its Council of Ministers. Meanwhile, the U.N. Environment Programme (UNEP) and the U.N. Economic Commission for Europe (ECE) are encouraging support for environmental impact assessment procedures. The ECE is sponsoring a major conference of experts from its member states on environmental assessment at Villach, Austria, in September 1979.

In July 1978, the U.S. Senate passed unanimously a resolution introduced by Senator Claiborne Pell, which urges the U.S. government to promote an international treaty that would use "international environmental assessments" to identify and deal with potential transboundary environmental problems.[90]

Under the proposal, nations would:

- Prepare international environmental assessments for any major actions taken within their own territory or in the global commons, such as the high seas, that could be expected to have a significant

harmful effect on the environment of another nation or a global commons area;

- Send the environmental assessment to the affected country or, in the case of the global commons, to UNEP before initiating the action;
- Consult, upon request, with affected states or with UNEP to prevent or minimize potential adverse effects of planned actions;
- Refrain temporarily, upon request of the affected country, from an action that might have an adverse environmental effect, in order to permit consultation; and
- Work together to settle disputes arising from environmental problems.

The United States announced its intention to seek an international environmental assessment arrangement along these lines during the seventh session of the UNEP Governing Council in Nairobi in April and May 1979.[91] The proposal was also included in the U.S. statement at the OECD Environment Committee ministerial meeting in May.[92] If consultations with other governments show that there is sufficient interest, the United States will consider proposing at the fall 1979 session of the U.N. General Assembly, a UNEP work program that could lead to an international agreement in a few years.

POPULATION

A fundamental factor shaping the quality of the environment for humankind is the unprecedented growth in human population occurring in this century. In 1930, the world's population stood at 2 billion, but by 1975—only 45 years later—it had doubled to 4 billion. Projecting to the year 2000, the United Nations in its most optimistic calculation estimates a population of 5.8 billion. This estimate assumes a one-third decline in fertility—the U.N.'s medium projection, which assumes a 24 percent decline in fertility, projects a world population of 6.25 billion in 2000. According to the estimates, world population may stabilize at 8 to 11 billion early in the 21st century.[93]

The worldwide rate of population growth has declined from about 2 percent in 1955 to 1969 to something under 2 percent at present. Nevertheless, overall population continues to rise. Because most of the people in the world are young and have their childbearing years ahead of them, there is a built-in momentum toward population growth. This means that even if it were possible to obtain within the next few decades a world fertility level that would merely replace the parental generation, population would continue to grow for 50 to 70 years thereafter.[94] Another notable element of the world population picture is the great disparity between growth rates in the developed countries, which average 0.7 percent, and those of the less developed countries, which average 2.1 to 2.4 percent. Some developing countries have growth rates well above 3 percent.[95]

This family planning health center serves a poverty-stricken area in Bombay.

In recent years, governments have begun to take steps to slow the rate of population growth. Four-fifths of the people in the developing world live in countries where governments have adopted population programs related to their development plans. About 30 of these countries appear to have reduced their birth rates by 10 to 40 percent between 1965 and 1975. External assistance to the developing countries for population control measures amounted to about $2.1 billion in the period 1965 to 1978.[96]

In 1978, the House of Representatives formed a Select Committee on Population, which conducted extensive hearings of both international and domestic population issues. Among the Committee's principal findings and conclusions were that: [97]

- Moderate to strong family programs have had a significant impact on fertility in developing countries;
- Active population and development efforts should be pursued simultaneously; they are integrally related and mutually reinforcing;
- Population programs have been allocated a disproportionately small percentage of international development assistance funds;
- The nature and extent to which population and development programs are integrated should depend on an assessment of the needs, wants, and capabilities of the societies being served;
- There is clear need for expanded public support of research aimed at development of more effective, safe, and acceptable contraceptives, in diverse social and cultural settings; and

- Social science research can be instrumental in identifying and clarifying relationships between population and overall development.

The Committee asked for a commitment to population activities at the highest levels of the U.S. government.

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CHAPTER 12

ECONOMICS

Environmental issues are inevitably economic issues. Whenever new environmental legislation is discussed or new regulations proposed to implement existing laws, the same set of questions is asked: Will the proposed regulations boost prices and, if so, how much? Will they result in the loss of jobs or the closure of plants and, if so, how many? What will the regulations do to the nation's balance of trade, the productivity of the workforce, or the rate of innovation? Is there a less expensive (or more "cost effective") way to accomplish the same objective? A more general, though often unstated, question is this: Is there really a *need* for these regulations, in this form, at this time?

Questions like these have moved to the front page in the past several years because economic problems—continuing inflation, stubborn unemployment, the declining dollar, lagging productivity—have persisted as front page items.

Yet the quality of the environment and the adequacy of its resource base are among this country's greatest national assets, assets with economic as well as other dimensions. Free disposal of household, commercial, and industrial wastes on the land or in the air and water in the past encouraged gross overuse of the assimilative capacity of the environment. Although air, land, and water can naturally process a wide variety of pollutants, their capacity to do so is limited. Moreover, this capacity is only one of the many kinds of services that flow from the natural environment. The nation now recognizes that the capacity of the natural environment to process wastes is not only finite but also often incompatible with other uses. This recognition was a major force behind the environmental legislation of the early 1970s.

The protection of human health and well-being; the sound management of land and other natural resources; the enhancement of scenic beauty and outdoor recreation; the preservation of wilderness; the protection of endangered plant and animal life: these are among the considerable rewards that stem from sound environmental policy. It is against these rewards that the economic dislocations that sometimes result from environmental policy must be compared.

This chapter puts into perspective these rewards and dislocations, or benefits and costs, as they are often called, intending to illuminate certain of the issues in the familiar but often misguided debate over the economic effects of environmental regulation. The chapter first discusses several ways in which the public debate about regulation has tended to obscure some important issues that need to be brought to light and better understood. Then some of the practical difficulties encountered in estimating economic benefits are discussed, as well as several controversial aspects of the methodology of cost-benefit analysis. Some results of a recent CEQ survey and analysis of air and water pollution benefit studies are presented, followed by estimates of the current and future costs of environmental regulations, and some of the macroeconomic consequences of those costs. The chapter concludes with the use of economic incentives as tools of environmental policy and how they might creatively supplant or supplement current regulatory approaches to environmental protection.

ECONOMICS AND ENVIRONMENTAL REGULATION

A major criticism leveled at environmental and other regulations is that they are inflationary, adding to the already high cost of living. Yet others claim the opposite—that these regulations are in fact deflationary and actually lower the cost of living. The confusion engendered may stand in the way of sophisticated decisions about regulation, decisions that could both raise the general price level, yet benefit the nation at the same time.

Conventionally, inflation is defined as an increase in the Consumer Price Index (CPI) during some period of time. The CPI is a composite measure of the average prices of a fixed collection, or market basket, of goods and services.[1] The market basket is made up of the things for which typical households spend their money—food, housing, clothing, medical care, transportation, entertainment, and so forth. Thus, when it costs more to buy the same collection of goods and services than it did previously, the CPI rises and the economy is said to be experiencing inflation.

And rise it has. During 1978, the CPI rose 9.3 percent while two of its major components, food and housing, increased by more than 10 percent. The Council of Economic Advisors estimated in January 1979 that the CPI would increase 7.4 percent during 1979,[2] but indications are that dramatic increases in energy and other prices will force it considerably higher.[3] By contrast, the CPI increased at an average annual rate of only 1.3 percent from 1960 to 1965, 4.5 percent from 1965 to 1970, and 6.9 percent from 1970 to 1975. These statistics confirm that prices are not only increasing, but seem to be doing so at an accelerating rate. This apparent acceleration accounts for the attention the administration has devoted to anti-inflationary strategies.

The possible causes of inflation are many, and the debate never ending on the relative contributions of each. Among the possible contributing factors are: deficits in the federal budget; an excessive rate of growth of the money supply; the market power exercised by big business and organized labor; minimum wage legislation; the OPEC cartel; tariffs, import quotas, and other trade restrictions; agricultural price supports; natural causes (poor harvests, etc.); local growth controls limiting new housing construction; and finally, environmental and other federal regulations.

But what is the link between environmental and other regulations on the one hand and changes in the CPI on the other? Why scrutinize air and water pollution control programs, for example, just because prices are rising too fast?

There are a number of ways in which the costs of cleaning up the nation's air and water, or the costs necessitated by other environmental legislation, can push up the CPI:

- Direct effects—Firms affected by environmental legislation can be expected to pass through at least some of the direct costs of undertaking pollution control in the form of higher prices. This pass-through includes both the cost of new capital equipment and the cost of its operation and maintenance. However, not all pollution control costs are necessarily passed on to consumers in the form of higher prices. This will depend on the tax advantages that may exist for certain pollution control expenditures (some cleanup equipment can be financed through tax-free bonds, for example), the firm's pricing policy, and its competitive position in both domestic and international markets. Depending on these tax and competitive considerations, pollution control costs may show up in increased individual income taxes (to make up for lost revenues from corporate taxes) or in the form of reduced wages or payments to stockholders.
- Indirect effects—The prices that a firm charges for its products will also be influenced by the pollution control spending of its suppliers. Thus, automobiles may increase in price not only because of the pollution control expenditures of the car makers themselves, but also because the makers of steel, rubber, and aluminum must make similar efforts.

Through these direct and indirect means, pollution control costs have their primary effect on the CPI. They may affect it in other ways, too. These include:

- Transactions costs—Some direct costs of pollution control may not be adequately reported or accounted for because they are not fully recognized or properly attributed. Examples include increased spending for the design of facilities, the cost of obtaining permits, research costs, and the administrative costs associated with complying with government regulations. One might also include in this category any costs associated with the delay of projects or with the uncertainties that regulation may introduce. These transactions

costs are not trivial, but it is unlikely that they rival the direct and indirect effects of pollution control costs.

- Productivity effects—Especially during periods of strong economic expansion, spending for pollution control may sometimes divert capital away from output-expanding uses. In addition, workers that might be employed in production may be required to operate and maintain pollution control equipment. If as a result measured output fails to grow, and if payments to other factors remain constant, final product prices must go up if workers are to be paid more. Hence, environmental regulation may affect the CPI through its effects on labor productivity. (This is discussed in greater detail below.) At the same time, it is important to recognize that new pollution control requirements may actually stimulate innovation in industries in which it would otherwise be absent, as new, cleaner methods of production must be contemplated.
- Demand effects—Pollution control regulations may suddenly and substantially increase the demand for certain goods and drive their prices up. For example, a new law may require the immediate installation of many more pollution control devices or the use of more gallons of unleaded gasoline than can currently be produced. If so, prices of pollution control equipment or unleaded gas may rise quickly.

Although environmental regulations can contribute to inflation, they—or any other programs—must be judged on broader grounds. Indeed, price increases are not always necessarily a bad thing.

One of the advantages of a properly functioning market economy is the information conveyed by product prices. For example, under certain circumstances the price of a product indicates how much in the way of other goods and services society must give up to have that product. This will be true when there is equality between what economists call the private and social costs of production. Private costs of production are those the producer actually bears—labor charges, the cost of capital, rent, utilities, and so on. Social costs include not only private costs but also certain other costs that some producers in the past have been able to escape paying—for example, the medical costs incurred by those subjected to the air pollution from a nearby plant, or the loss of livelihood of fishermen who find their catches affected by upstream water pollution. In the past, neither cost was reflected in the economic calculations made by the firm, nor were they reflected in the prices that consumers paid for the products whose production caused the pollution.

Historically, a major cause of divergence between private and social costs has been these so-called "externalities" that resulted when manufacturers and other producers were not required to abate pollution, protect their workers from occupational health hazards, or dispose of their wastes in a safe fashion. The environmental legislation now being scrutinized was drafted in response to this divergence

between private and social costs. It was based on the clear recognition that existing market prices were giving incorrect signals to consumers by understating what society was giving up to have goods whose production resulted in pollution.

Hence, when environmental regulations lead to higher prices, through the mechanisms described above, it is *not* an unnecessary interference with a properly functioning economy. Quite the contrary, such regulation is essential to its operation. These higher prices induce consumers to shift their expenditures to other, perhaps "cleaner" goods and services. In addition, higher prices signal producers that profits can be made if they can find a way to produce in a nonpolluting fashion. Therefore, although no one likes paying more for the same product, the higher prices that may result from regulation may improve the overall allocation of the nation's resources.

Taking this discussion a step further, there are several arguments that can be made in support of the claim that environmental regulation, far from fueling inflation, is actually deflationary.

For example, suppose goods in the fixed market basket are categorized as either "discretionary" products consumers buy because they enjoy the services they provide, or "defensive," items—such as medical care, insurance, or burglar alarms—that provide no satisfaction in and of themselves. Among other things, environmental regulations may alleviate the need for certain kinds of defensive expenditures—medical care, crop protection, and water treatment costs, for example. To the extent such regulations allow consumers to reduce spending for defensive goods by more than the amount they may add to the prices of discretionary goods, the regulations may actually allow increased consumption of discretionary goods. In this sense, environmental regulation can increase the standard of living and might therefore fairly be called deflationary.

One might also argue that the CPI takes inadequate account of changes in product quality and that a proper adjustment would show environmental regulation to be deflationary. This argument requires some bending of standard practice to support it. But the bending is already occurring with respect to new car prices. Arguing that new cars are actually better cars because they emit fewer pollutants, the Department of Labor attempts to adjust for this "quality" improvement by deducting some base-year cost of pollution control devices from new car prices before entering them into the CPI calculation. Similar reasoning could be extended to other products. A refrigerator bought today, for example, might actually be considered a "better" product than it was before the introduction of air and water pollution regulations, because less pollution is emitted in its production. If the benefits of reduced pollution exceed the abatement costs, similar adjustments to the price of all "dirty" products (those whose production entails pollution) would result in a situation in

which the corrected prices fell as a result of regulation. In this sense, the programs would be deflationary.

This same argument can be restated in a slightly different form. Environmental regulation can be viewed as adding to the size of the standard market basket. That is, regulation allows consumers to enjoy not only the same clothes, foodstuffs, housing, and so on as before, but also more environmental amenities. Therefore, consumers really are not paying more for the same collection of goods and services; rather, they are enjoying an "augmented market basket" in which the price increases of the conventional items actually represent payments for additional, conventionally ignored, environmental services. Because they are not paying more for the same things, environmental regulation may not be considered inflationary.

How persuasive are these arguments? Should the CPI be modified to account for environmental improvements? Several factors argue against such a change. First, the problem is not with the index itself—which does its intended job adequately—but rather with misinterpretations of the CPI. Second, attempting to modify the CPI would be awkward. Much work has gone into perfecting its computation; much more would be required to take satisfactory account in the index of the environment and the services it provides. For example, how would one unit of environmental quality be defined to make it comparable to a pound of hamburger, a gallon of gasoline, a pair of socks, or other items in the CPI? And how would such a unit be valued, so that it could be decided whether the price increases of conventional goods were more or less than offset by environmental quality gains? Finally, how would the average household's consumption of environmental amenities be determined? Although these questions are not unanswerable—indeed, they must be answered if the benefits of environmental protection are to be estimated—they suggest that the CPI might best be left alone.

On the other hand, it sometimes appears that regulation, or any other government action for that matter, is judged with reference to one narrow national economic goal—lower prices. To the extent this is so, a revised CPI, supplementing the existing CPI, might not be a bad idea. It would have the distinct advantage of portraying well-designed environmental regulation as noninflationary, and hence acceptable to those whose barometer of acceptability is the CPI. This may be desirable as long as those attuned to that barometer are not willing to look beyond it to other, equally important measures of social well-being.

Consider briefly two other facets of the debate about environmental regulation—its effects on economic growth and the productivity of labor. Economic growth usually means the annual rate of increase in real (or inflation-adjusted) gross national product (GNP). GNP is a measure of the total market value of the goods and services produced in a particular year. The effect that regulation, or any other alteration in public or private behavior, has on

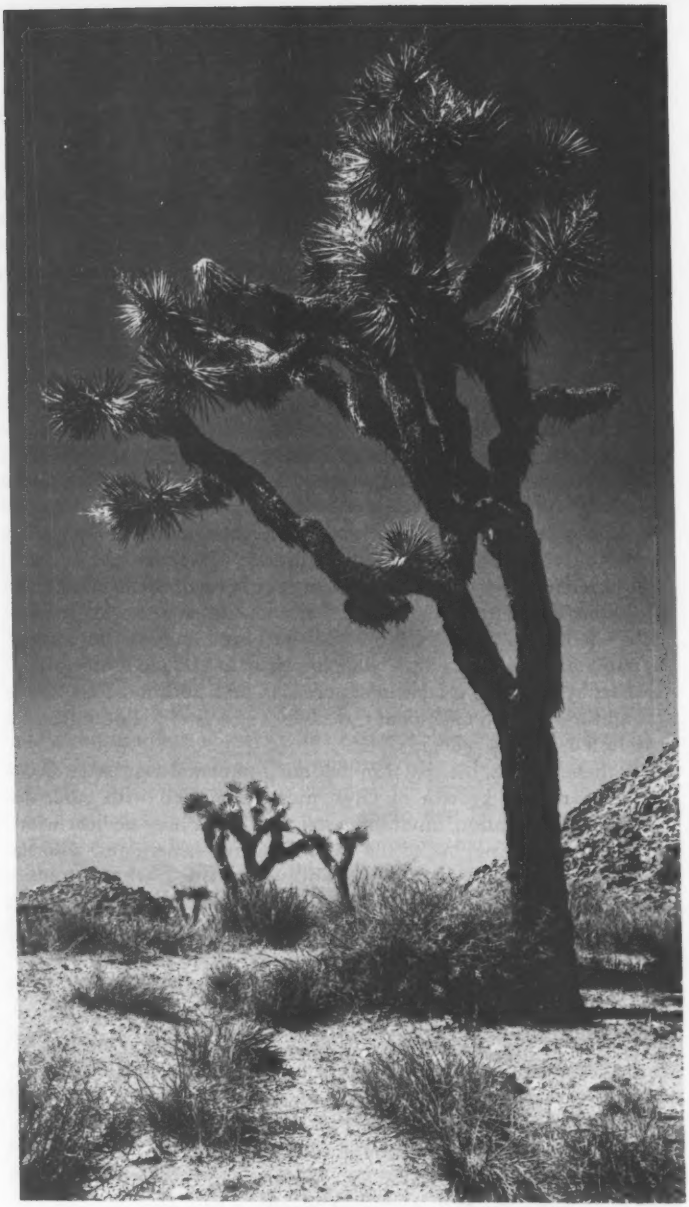
the rate of growth of real GNP is important because real output is one measure of the strength of the economy. Unfortunately, like the CPI, GNP is frequently misinterpreted as a measure of overall national welfare or well-being. It is erroneous to draw such a conclusion. In fact, while recognizing its usefulness for certain purposes, both economists and noneconomists have leveled serious criticism at GNP as a welfare indicator.[4]

Foremost among the criticisms is that GNP is a measure of the goods and services produced in a year, rather than those consumed.[5] Economists generally view the consumption of goods and services, and the enjoyment derived from them, as the true measure of economic well-being. Because GNP is a production-oriented index, it is clearly deficient in this respect. Still another deficiency of GNP as a welfare measure is that it ignores certain kinds of goods and services. For example, the services of men or women who work in the home cooking, cleaning, and maintaining a household are not included in the GNP accounts, although the earnings of paid domestic workers, who perform identical services, are included. Similarly, GNP falls when a worker elects to work fewer hours in exchange for more leisure time even though such a decision, if voluntary, is to that individual's advantage. This inadequate treatment of leisure is another shortcoming of GNP as an indicator of well-being.

Most relevant is the treatment of the environment in the GNP. The enjoyment that citizens derive from cleaner air or water, or from a day spent in a national park or wilderness area, fails to show up in the national income accounts.[6] The impairment of these environmental assets by pollution is likewise ignored. In fact, additional defensive expenditures needed to combat the adverse effects of pollution would be reflected in an *increase* in GNP.

For these reasons, the criticism that environmental regulation slows down the rate of growth of GNP must be viewed with care. As in the case of inflation, environmental regulation may do just what it is accused of doing, but to the nation's overall benefit and with its complete, though tacit, agreement. This will be true if what is traded in conventionally measured output—that is, the items reflected in the calculation of GNP, such as cars, shoes, or chemicals—is worth less to the nation than environmental benefits flowing from regulation that are not measured in GNP, but are valued more highly.

Here, too, it might be worthwhile to develop an additional measure of well-being, one that combines elements of GNP with a number of the important considerations it omits. In fact, several such expanded measures of well-being have been proposed. For example, the Economic Council of Japan has developed a Net National Welfare Measure designed to take account of leisure, nonmarket household activities, the services rendered by capital stocks, defensive expenditures by government, the unpleasant aspects of urbanization, and environmental degradation.[7] The Bureau of Economic Analysis in the Department of Commerce has recently created a separate branch to



The enjoyment people get from visiting national parks or wilderness areas is a component of economic well-being that does not show up in the Gross National Product. Above, the Joshua Tree National Monument, Calif.

study such possibilities for the United States—a welcome step toward eliminating the confusion surrounding the meaning of changes in GNP.

Equal consideration must be given to the effects of environmental and other regulation on the productivity of labor. Here, again, the conventional definition of output in part contributes to the confusion about regulation and its economic effects. Productivity is defined as the amount of measured output that is produced by a worker during some fixed period of time. This measured output includes the items of which GNP is made—clothes, cars, ball-bearings, and so forth. But it does *not* normally include improvements in the health and safety of the populace, the purification of the nation's air or water, nor the enhancement of either wilderness areas, wildlife refuges or the everyday environment.

Hence, although output-per-person-hour (or some other such measure of productivity) provides some useful information about the rate at which the production of certain items is increasing, it is a far from perfect measure of the ability of the economy to generate increased well-being. In essence, environmental regulation makes possible the creation of nonmarketed goods and services, like clean air and water, sometimes at the expense of marketed goods. Therefore, a market-oriented measure of productivity will generally decline when environmental regulation takes effect, even though the regulation may generate an untabulated increase in well-being.

Nor should environmental or other kinds of regulation be cited as the primary factor contributing to the productivity slowdown. Recent studies indicate that other nonregulatory forces account for a large share of the decline.[8] These other factors include the recent entry into the labor force of large numbers of teenagers and women with little previous work experience; the increasing share of output accounted for by the service sector, where productivity gains are not only more difficult to measure but also harder to come by than in manufacturing; cyclical variations in general economic activity that affect the intensity with which labor and capacity are utilized; and the recent and rapid increase in the price of oil that may have caused manufacturers to substitute labor for energy in the production process. In addition to these influences, productivity growth is lagging behind its historical rate because workers have ceased their migration from rural to urban areas where they have generally been more productively employed.

Moreover, in one special case, productivity can differ from other economic factors in its relationship to environmental regulations. Even as conventionally measured, productivity might increase following regulation if the regulation were to reduce pollution-related illness or otherwise improve the well-being of the labor force. The production of workers made healthier by a cleaner environment may increase by enough to offset productivity declines resulting from the diversion of workers and capital to so-called nonproductive uses. For the time

being, insufficient data exist to determine whether this is occurring but the possibility is real.

THE BENEFITS OF ENVIRONMENTAL QUALITY

PRINCIPLES

Estimating the benefits resulting from environmental regulations is as difficult as it is important. Because they have been discussed thoroughly in recent issues of *Environmental Quality,* the difficulties and technical problems encountered in estimating benefits (or "damage costs") are touched on only lightly here. Several more fundamental questions about the methodology underlying benefit estimation, about which less was said in the past, are given lengthier consideration. Following this, some of the results of a recent CEQ study surveying the state of environmental benefit estimation are presented.

Four major steps are involved in calculating the economic benefits expected from a particular environmental regulation. First, the effect the regulation will have on those being regulated must be determined. How many fewer gallons or pounds of pollutants will be discharged as a result of a regulation and its enforcement? How many more acres of land will be reclaimed following surface mining? How much quieter will cities be following noise control ordinances? The effect of regulations will clearly depend on a number of uncertain factors—the attitude of those being regulated, the effectiveness of the control techniques employed, the vigor with which they are enforced, the severity of any court-imposed penalties for violation, and so on. Uncertainties at this very first stage are extremely important but are often ignored in benefit estimation.

Next, the effect of the reduction in emissions (or other offending activity) must be translated into improvements in ambient environmental conditions. These latter depend not only on discharges of pollution but also on variation in weather and climate, the changes of seasons, synergistic effects between different pollutants, and so on. Hence, a given discharge may have very little effect on air or water quality at one time of day or year, yet cause serious problems at another.

The third step in benefit estimation requires that changes in ambient environmental quality resulting from regulation be translated into physical effects. In other words, to what extent does cleaner air, for example, mean healthier citizens; less materials damage (corrosion, soiling, etc.); enhanced aesthetic enjoyment of vistas, parks, or everyday neighborhoods; more agricultural output; and the like? Similarly, cleaner water brings with it increased recreational and commercial fishing and boating, more places for safe swimming, reduced water treatment costs, certain health improvements, and other advantages. Some of the physical effects of reduced pollution may

Cleaner water means enhanced esthetic enjoyment of rivers, lakes, and beaches.

not be too difficult to measure. For example, by comparing the outputs of two farms, identical in all respects save for exposure to air pollution, it may be possible to predict how crop yields might increase if air pollution were reduced. Other effects are extremely difficult to isolate. Human health, for example, depends on a whole constellation of environmental, socioeconomic, and other influences. Although statistical techniques are beginning to help us unravel the effects on health of specific, isolated phenomena such as air or water pollution, this is still a relatively primitive undertaking. Similarly, it is difficult to know how much more pleasing individuals find unpolluted air or how much more water-based recreaton they will undertake when rivers and lakes become useable once again.

If these other obstacles can be overcome (and this has not been easy, nor will it become so), a final step remains—valuing the physical effects, so that the benefits of environmental regulation can be expressed in a fashion commensurate with its costs. This may be the most difficult step of all because it is not only a scientific matter, as the other steps have been, but also a philosophical one. It leads us to the knotty methodological questions alluded to above.

To be sure, not all valuation is so problematical. Suppose, to take an earlier example, that agricultural output will increase by 5 percent following air pollution control. It is then a straightforward process to multiply the added crops by their market price to obtain a perfectly adequate estimate of that component of benefits. Similarly,

if municipal water treatment costs in a community decrease by $1 million annually because of water pollution control upstream, that dollar reduction can serve as a reasonable estimate of that part of overall benefits. The valuation of increased commercial fishing yields or of materials damages avoided can be straightforward in certain instances.

But what of the much more difficult valuation problems—those involving the prolongation of life, the amelioration of serious illness, the preservation of endangered species, or even the enhancement of a recreational or wilderness experience? In such cases, can dollar values be placed on regulatory "outputs?" And if so, how should it be done? There is well-developed, although hardly conclusive, literature in economics and related disciplines on just this subject; this report cannot attempt to give comprehensive answers to these questions. But the questions *do* highlight certain uneasy assumptions that underlie benefit estimation.

Economists define the benefits of environmental regulation or any other governmental undertaking as the total amount that society is willing to pay for the favorable effects resulting from the regulation. Expressing the many dimensions of these effects in dollar terms is puzzling and unsettling to many people.

First, consider the attempted dollar valuation of human lives, the preservation of a species, or other such extraordinary consequences of regulation. Does this confirm the platitude that "economists know the price of everything and the value of nothing?" Not necessarily, because this valuation must be made if cost-benefit analysis is pushed to its limit, where all the good and bad effects of public actions are valued commensurately. Of course, there is nothing sacred about the use of dollars as the unit of measurement. The purpose of benefit-cost analysis would be well served if these effects were readily expressed in terms of pears, roses, salt, or any other common denominator. A common unit only makes it easy and convenient to weigh the good and bad effects of regulation or other public intervention. It makes possible a comparison of apples with apples rather than the more difficult, if more familiar, apples-oranges comparison.

Because costs are almost always expressed in dollar terms, it is convenient to express benefits in the same terms. Hence, it is the search for a common yardstick that prompts the difficult and unpopular dollar valuation of "priceless" effects rather than a belief in the primacy of dollars on the list of things sacred.

Note that refusal to value human lives or other physical benefits in dollars on principle does not avoid the problem. Consider the typical budgetary decisions made at any level of government. At least some options involve life-saving programs—these could be local traffic safety expenditures, state health programs, federal environmental programs, or similar efforts. Other types of government programs produce valuable benefits as well—education, cultural enhancement, clean and speedy transportation, decent housing—but may not save

lives. When officials fund these latter kinds of programs rather than say, a $10 million safety program that is expected to save 25 lives, they are *implicitly* revealing their unwillingness to spend $400,000 to save a life. They are *not* claiming that a human life is "worth" less than that. Rather, they are making the judgment that other programs are more deserving. But in so doing they place a kind of "price" on a life.

This kind of implicit valuation is inevitable. Therefore, it might be useful for the government to establish explicitly how much it is willing to spend to save lives. This would have at least one desirable result. Suppose officials in one branch of government or in one agency decide not to spend more than $200,000 to save a life, although elsewhere programs are funded that will save lives for $400,000. By transferring funds from the latter to the former, the government could save two lives for every one saved through the latter program. Why spend $400,000 to save a life through a highway safety program, for example, when that same sum spent on inoculations or some other program might save even more lives? Unpleasant as it may be, the explicit determination of the amount government is willing to spend on saving lives may enable it to save the greatest number of lives for a given amount of money. This is the rationale for "valuing a human life," *not* the notion that lives should be exchanged like other commodities on the open market. Nevertheless, such valuation is an extraordinarily sensitive matter, and it is as much the province of politicians and philosophers as economists.

The use of money as a measuring rod is not the only troubling aspect of benefit valuation. As stated, willingness to pay for the favorable effects of a regulation is the economists' measure of the benefit derived from it. Yet the amount individuals are willing to pay for improved public transportation, cleaner air, quieter neighborhoods, or the other possible effects of regulation obviously depends on their income and assets. An identical improvement in air quality, therefore, will probably be valued more highly by the prince than the pauper, and hence the benefits of a similar air quality improvement in "princely neighborhoods" will exceed those in slums. Therefore, any benefit estimate is contingent on the existing distribution of income. To the extent society is dissatisfied with that distribution, any benefit estimates based on it will be regarded as illegitimate.

Should these problems with benefit estimation lead to its abandonment? Probably not, although they are certainly a warning to look carefully at the assumptions underlying the practice. One reason not to reject benefit estimation is that willingness to pay does give one measure of the dollar value of the benefits of a program, a sum that can be compared to its cost. In the absence of such an individualistic concept of benefits—one based on the preferences of citizens—some measure of what is good for society as a whole would be required. Yet such an "organic theory of the state" presents as many or more philosophical and operational difficulties in benefit measurement as

does application of the willingness-to-pay criterion. Hence, imperfect though it may be, such a criterion does simplify—though perhaps oversimplify—a very difficult job.

One further aspect of benefit estimation and cost-benefit analysis deserves mention. A presumption in benefit-cost analysis is that when the benefits and costs associated with a project are totaled, if the benefits exceed the cost the project or regulation should be approved—to economists the project is "efficient." The reason an efficient project merits approval is that, *in theory,* everyone could be made better off by it. In other words, the gains resulting from the project could be divided among all citizens so that the lot of each is improved.

However, theory and practice seldom converge. And usually a regulation will make some citizens better off (the workers protected by an occupational safety regulation, for example) and some worse off (consumers paying higher product prices than before the safety changes were made). Therefore, even though the gains to the beneficiaries outweigh the losses to others, some unfortunates are made worse off because the compensation that could be made, in actuality is not made. When a great many benefit and a great many absorb the costs, this seems unobjectionable. But the number of beneficiaries can sometimes be small and so can the group disadvantaged by the policy. In this case, even a highly efficient policy may appear undesirable because one group so obviously benefits at the expense of another.

To complicate matters further still, what if the beneficiaries of a policy are wealthy while those incurring burdens are poor? Should we accept this distributional perversity because gains exceed losses? Such cases as these point out the necessity of supplementing conventional benefit-cost analyses with additional information. First, whenever possible, such analyses should present not only totals of benefits and costs; they should also indicate the income and perhaps even the racial, ethnic, or geographic identity of those who gain and lose. Second, whenever feasible, those who benefit from regulatory or other policies should compensate those who lose. This will insure that economically efficient policies will also be politically acceptable. Arranging such compensation will generally be an impossible task—most environmental policies, for example, affect millions of individuals in complex ways. But when those affected are readily identifiable, compensation makes good economic sense and broadens the base of support for benefit-cost analysis and other tools intended to assist in decisionmaking.

BENEFIT ESTIMATES

Notwithstanding the difficulties described above, a number of studies over the last decade have attempted to estimate the annual dollar benefits of federal air and water pollution control efforts. The results of these studies have often disagreed. This has made it difficult

Mussels, clams, and oysters living sedentarily on the floor of coastal waters are highly sensitive to pollution. The exact correlation between water quality improvements and greater abundance of shellfish is difficult to estimate.

for policymakers and citizens to judge the attractiveness of environmental protection from an economic standpoint.

There are a number of reasons for the apparent conflict among the estimates. First, and most fundamentally, different studies have produced different estimates of so-called "dose-response" relationships—that is, the correlation between air pollution and human health or agricultural output; or between water pollution and fish stocks and other aquatic life; or between water quality improvements and swimming, boating, and fishing. Exactly how many illnesses a year, for example, does a given increase in sulfur dioxide and particulate emissions produce? The answers to such questions differ markedly in different studies.

In addition, benefit estimates sometimes differ because identical physical effects are valued differently. For example, a life saved may be valued according to future lifetime earnings in one study; another study may use an entirely different (and more acceptable) method based on individuals' valuations of reduced risk. Similarly, different studies attribute different values to days off the job on account of illness that may be averted by air pollution control.

Benefit studies differ in simpler ways as well. Some calculate the benefits expected from the eventual full implementation of air or water pollution control laws; others relate benefits only to those environmental improvements already being enjoyed; still others are based on some hypothetical improvement in air or water quality. Several studies attempt to make comprehensive, national benefit estimates, while others consider only a single region or concentrate on one particular component of environmental benefits. Some benefits are estimated in 1978 dollars while others use earlier, less inflated dollars as a yardstick.

Many of these differences can be reconciled, some quite easily, and the estimates compared on a more equal footing. A study undertaken for CEQ during the year sought to do just that.[9] The report was not intended to develop any new estimates of air and water pollution control benefits, but to facilitate comparisons of existing studies. Three adjustments were made. First, the study expressed all previous estimates in 1978 dollars. Second, it valued all physical improvements identically. Finally, it standardized the change in environmental quality upon which the various estimates were based; that is, it recalculated benefits, applying the various dose-response relationships contained in each of the original studies to uniform improvements in various aspects of environmental quality.

For air pollution, the uniform improvement was taken to be a 20 percent reduction in average ambient concentrations of sulfur dioxide and suspended particulates. This, the study concluded, is approximately the measured improvement in air quality for these pollutants between 1970 and 1978. The CEQ study pointed out that the benefits from measured air quality improvements since 1970 are only a portion of the total benefits flowing from the Clean Air Act. This is because the pollution controls required by the Act not only improved air quality but also prevented deterioration that would probably have occurred in its absence. Thus, the total national benefits from air pollution control identified in the study should be regarded as conservative, perhaps considerably so.

Most studies of water pollution control benefits are based on the eventual installation by 1985 of best available treatment technology by industrial and municipal point sources. The study done for CEQ used this basis for comparing the various studies of water pollution control benefits. Thus, unlike air quality benefits, which are based on improvements that have already occurred, the water quality benefits are those that will be enjoyed from full compliance with the Clean Water Act in the future.

Even after standardizing the studies in the ways discussed above, the report to CEQ found major divergences among estimates of air and water pollution control benefits. Thus, it must be concluded that the lack of a common methodology is not the only reason why previous benefits estimates differed so greatly. Instead, major differences often arise from fundamentally different findings about pollution and its effects on the environment. For example, even after expressing estimates in 1978 dollars and standardizing for a 20 percent improvement in air quality, the study found that estimates of the health benefits of controlling air pollution from stationary sources still ranged from $1.8 billion to $14.4 billion. A similar though less prononuced variation exists for water pollution. For instance, one analysis found that water pollution control benefits in the form of improved freshwater fishing would lie in the range of $0.3 to $0.7 billion. Another analysis estimated this same category of benefits as being in the range of $2.5 to $15.1 billion.

Because the ranges identified in the report to CEQ were so large, the study went further and selected a "most reasonable point estimate" (the single, most likely value) for both air and water pollution control benefits. This figure is based on a careful assessment of both the empirical and theoretical bases of the studies surveyed. However, it should be interpreted with care, since other inferences are possible from the studies examined.

According to the study done for CEQ, the annual benefits realized in 1978 from measured improvements in air quality since 1970 could be reasonably valued at $21.4 billion. Of this total, $17 billion represented reductions in mortality and morbidity, $2.0 billion reduced soiling and cleaning costs, $0.7 billion increased agricultural output, $0.9 billion prevention of corrosion and other materials damage, and $0.8 billion increases in property values.[10]

Based on the prior studies, the report to CEQ also developed a most reasonable point estimate of the total annual benefits to be enjoyed by 1985 as a result of the nation's water pollution control legislation. According to the report, benefits will amount to about $12.3 billion per year, with recreation benefits accounting for $6.7 billion, or about 54 percent of the total. Because of insufficient evidence this total does not include the possibly considerable health benefits from the elimination of chemical contamination in drinking water.

THE COSTS OF ENVIRONMENTAL QUALITY

MACROECONOMIC EFFECTS

There are several reasons why it is important to know the costs of existing and proposed environmental quality and natural resource programs. First, the relationship between the cost of a particular program and the benefits expected to flow from it is an important factor in judging the program. Second, knowing these costs makes possible a determination of the effects of a particular program or set of programs on the behavior of important macroeconomic aggregates—inflation and unemployment rates being obvious examples.

Since 1972, CEQ has pioneered in the effort to identify the macroeconomic consequences of federal environmental programs. Up-to-date studies of this kind have been made periodically with the onset of new environmental programs and improved estimates of the costs of existing ones. The most recent update was performed by Data Resources Incorporated (DRI) for CEQ and EPA, and published in final form in February 1979.[11]

The mechanics of employing a large econometric model of the United States to determine the impacts of federal pollution control programs are complicated, but the general approach can be described rather simply. CEQ provided DRI with estimates of pollution control costs that were based on actual pollution control expenditures in years past, collected by the Department of Commerce, and estimates of future pollution control expenditure requirements, prepared by EPA.

Estimates of air and water pollution control expenditures during the period 1970 to 1986 were made for automobiles; for individual industrial sectors; for publicly owned wastewater treatment facilities; for solid waste disposal facilities; for other public buildings and institutions; and for nonindustrial business sectors such as commercial establishments and transportation. These are the same cost estimates as those reported in CEQ's 1978 Annual Report.

It is important to note that the cost estimates given DRI were for the amounts spent in response to existing federal legislation, not for the total amounts spent on pollution control. CEQ refers to this category of costs as "incremental." They are the difference between total pollution control expenditures and CEQ's estimates of "baseline expenditures"—what businesses, governments, and households would have spent on pollution control in the absence of federal law. The baseline estimates are projected from public and private spending on pollution control in the middle 1960s before the amendments to the 1972 Federal Water Pollution Control Act [12] and the 1977 Clean Air Act [13] were passed.

Starting with incremental costs, the next step is to determine how, and by how much, they show up in the economy. By adjusting the appropriate equations of the econometric model, it is possible to characterize the structure of an economy operating *without* these abatement expenditures. For example, employment figures must be adjusted downward initially to reflect the absence of jobs in the pollution control industry; business investment must initially be reduced by the amount no longer required to be spent on pollution control; new car prices must be reduced to reflect the absence of pollution control equipment; and the spending of state and local governments must be reduced by the amount they spend to enforce and implement federal pollution control laws.

Then a basic set of assumptions must be made about the future values of the variables determined outside of the model ("exogenous" variables). For example, how much will the various levels of government spend for goods and services in the years to come? At what rates will income be taxed? How fast will the money supply expand? These considerations and many others like them are fundamental to any macroeconomic simulation.

Once the proper adjustments to the structure of the economy are made and appropriate values selected for the exogenous variables, all that remains is to run or "solve" the model. What results is a picture of the economy between 1970 and 1986 in the absence of the federal pollution control laws. This is compared with a similar computerized picture of the economy operating with the controls. For each measure of economic activity, the "with" entries describe the economy operating with the federal air and water pollution control laws in effect, while the "without" entries indicate the predicted levels of activity in the absence of these laws. The difference between these two views of the economy sheds light on how federal pollution control regulations affect the unemployment rate, the rate of price inflation,

the balance of trade, the rate at which real income grows, the productivity of labor, and a host of other important macroeconomic indicators.

Table 12–1 examines the rate of increase of the CPI. Between 1970 and 1978, federal environmental legislation added, on the average, slightly more than three-tenths of one percentage point to the annual rate of increase of the CPI. In other words, if the inflation rate in an "average" year was 6.5 percent, it would have been 6.2 percent in the absence of environmental controls. During 1973 and 1974, while the economy was operating almost at full capacity, environmental controls added one-half of one percentage point to the inflation rate, presumably because these controls diverted capital and labor from other conventionally productive uses.

According to DRI, with much of the required pollution control equipment now in place, the future contribution of existing environmental regulations to inflation will shrink. As a matter of fact, between 1979 and 1986, federal environmental regulations will add between one- and two-tenths of one percentage point to the annual inflation rate. For both 1979 and 1980, existing federal environmental regulation is predicted to add but one-tenth of a percentage point to the rate at which prices increase. The same is true for the period between 1984 and 1986. A little arithmetic points out the small contribution of environmental regulation to inflation. Because the predicted inflation rate for 1980 is 6.9 percent, according to DRI, environmental regulations now on the books will account for about

Table 12–1

Percentage Growth Rate of Consumer Product Index

Year	With Environmental Controls	Without Controls	Difference *
1970	5.9	5.8	0.1
1971	4.3	4.1	0.2
1972	3.3	3.0	0.3
1973	6.2	5.8	0.5
1974	11.0	10.5	0.5
1975	9.1	8.7	0.4
1976	5.8	5.4	0.4
1977	6.5	6.2	0.3
1978	7.5	7.3	0.2
1979	7.1	7.0	0.1
1980	6.9	6.8	0.1
1981	6.8	6.6	0.3
1982	6.3	6.0	0.3
1983	6.1	5.9	0.2
1984	5.9	5.8	0.1
1985	5.8	5.8	0.1
1986	5.7	5.7	0.1

* May not be exact due to rounding.

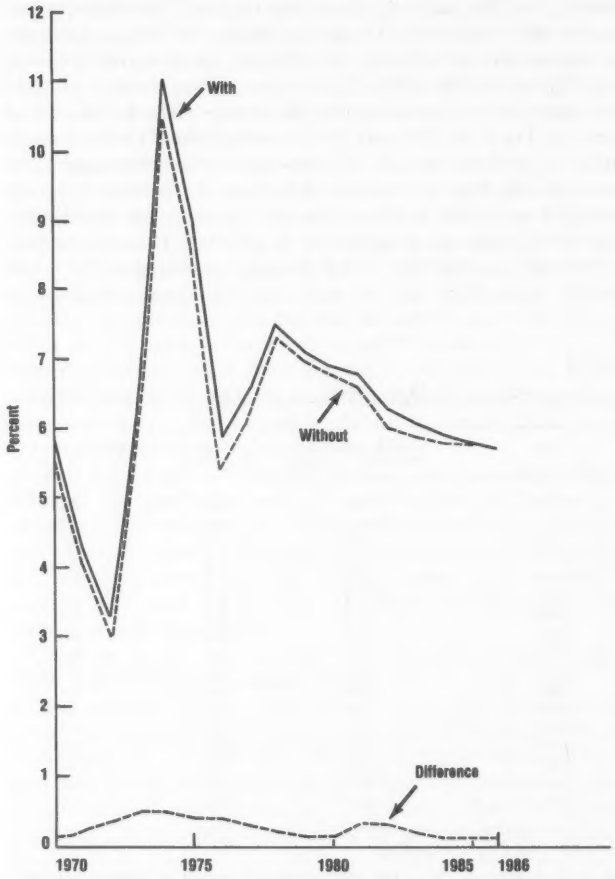
Source: Data Resources, Inc., *The Macroeconomic Impact of Federal Pollution Control Programs: 1978 Assessment*, submitted to the U.S. Environmental Protection Agency and CEQ, January 29, 1979.

one-seventieth of that increase (0.1 divided by 6.9). Figure 12–1 illustrates the movement of the CPI "with" and "without" environmental controls.

As Table 12–2 indicates, air and water pollution controls will serve to stimulate employment during the entire 16-year period. By creating jobs in the pollution control equipment industry and jobs for those who operate and maintain this equipment, environmental pro-

Figure 12–1

Percent Annual Increase in Consumer Price Index With and Without Environmental Controls



Source: Data Resources, Inc., "The Macroeconomic Impact of Federal Pollution Control Programs: 1978 Assessment," submitted to U.S. Environmental Protection Agency and CEQ, January 29, 1979.

Table 12–2

Unemployment Rate

(percent)

Year	With Environmental Controls	Without Controls	Difference *
1970	5.0	5.2	−0.2
1971	5.9	6.3	−0.3
1972	5.6	6.0	−0.4
1973	4.8	5.2	−0.3
1974	5.6	5.8	−0.2
1975	8.5	8.6	−0.2
1976	7.7	7.9	−0.2
1977	7.0	7.2	−0.2
1978	6.1	6.2	−0.1
1979	6.3	6.4	−0.2
1980	6.0	6.4	−0.4
1981	5.7	6.2	−0.4
1982	6.1	6.4	−0.3
1983	5.7	6.0	−0.2
1984	5.2	5.4	−0.2
1985	5.0	5.2	−0.2
1986	5.0	5.2	−0.2

* May not be exact due to rounding.

Source: Data Resources, Inc., *The Macroeconomic Impact of Federal Pollution Control Programs; 1978 Assessment*, submitted to the U.S. Environmental Protection Agency and CEQ, January 29, 1979.

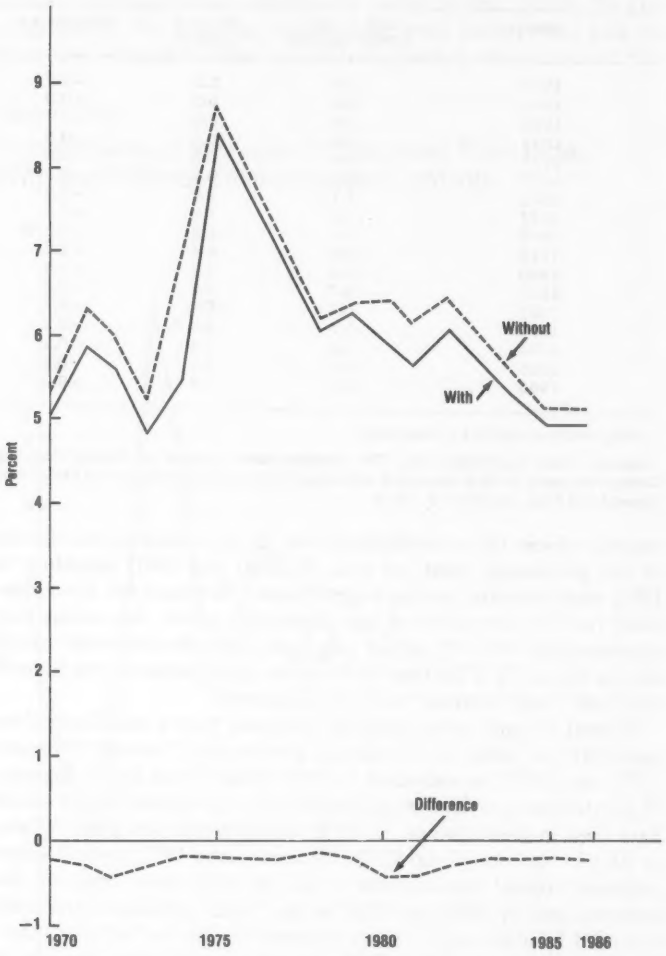
tection reduces the unemployment rate by an average of one-fourth of one percentage point per year. In 1980 and 1981, according to DRI, environmental quality expenditures will reduce the unemployment rate by four-tenths of one percentage point; this means that approximately 400,000 people will have jobs who otherwise would not. In Figure 12–2 the time paths of the unemployment rate in both the "with" and "without" cases are illustrated.

Federal air and water pollution programs have a mixed effect on real GNP, as Table 12–3 indicates. For instance, between 1970 and 1977, real GNP (as measured in 1977 dollars) was higher because of the stimulus provided by pollution control programs than it would have been in their absence. In 1972, the difference was $14.4 billion, or 0.9 of 1 percent of real GNP. However, after 1977, air and water pollution control expenditures began to exert some drag on the economy, and by 1986, real GNP in the "with" scenario is predicted to be $24.5 billion—or 1 percent—lower than in the "without" case. Nominal or current dollar GNP is always higher in the presence of pollution control, but this reflects the slightly higher prices caused by environmental spending. The effect of environmental regulation on GNP is shown in Figure 12–3.

As mentioned, the macroeconomic analysis performed by DRI depends on estimates of the expected incremental costs associated with existing federal air, water, and solid waste standards between 1979 and 1986. Because these estimates could be off for a variety of

Figure 12–2

Unemployment Rate With and Without Environmental Controls



Source: Data Resources, Inc., "The Macroeconomic Impact of Federal Pollution Control Programs: 1978 Assessment," submitted to U.S. Environmental Protection Agency and CEQ, January 29, 1979.

Table 12–3

Real Gross National Product

(billions of 1977 dollars)

Year	With Environmental Controls	Without Controls	Difference *
1970	1522.5	1515.3	7.2
1971	1568.2	1555.1	13.1
1972	1658.3	1643.8	14.4
1973	1748.7	1737.7	11.0
1974	1724.6	1718.8	5.8
1975	1702.6	1698.2	4.4
1976	1799.6	1793.8	5.8
1977	1886.8	1884.2	2.5
1978	1959.9	1963.6	−3.7
1979	2023.0	2021.9	1.1
1980	2118.8	2109.5	9.3
1981	2198.7	2183.5	6.2
1982	2250.9	2252.6	−1.8
1983	2351.9	2362.1	−10.2
1984	2457.0	2473.7	−16.7
1985	2543.5	2563.5	−20.0
1986	2622.3	2646.7	−24.5

* May not be exact due to rounding.

Source: Data Resources, Inc., *The Macroeconomic Impact of Federal Pollution Control Programs: 1978 Assessment*, submitted to the U.S. Environmental Protection Agency and CEQ, January 29, 1979.

reasons, an additional case was examined—one in which future pollution control outlays were assumed to be 20 percent higher than those estimated by EPA.

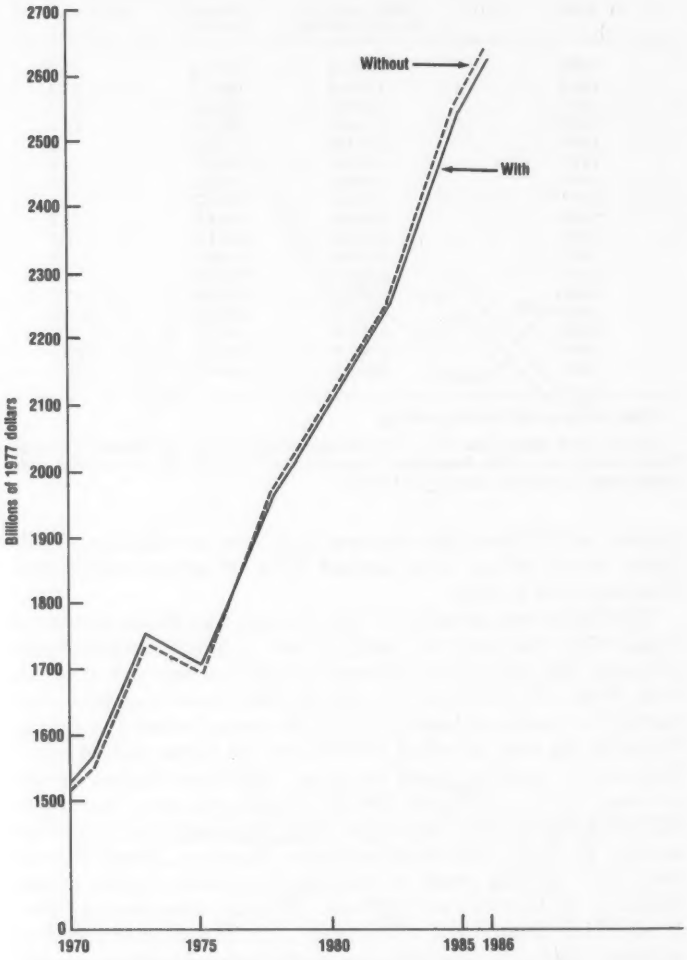
This higher-cost scenario can give a rough idea of the macroeconomic effects that might be exerted by new additional environmental programs that were not in existence or had not been priced at the time of the DRI study or, alternatively, they can be viewed as correcting for possible underestimation of the costs of existing programs. Whatever the case, according to DRI even this higher level of pollution control spending would not have a significant impact on the economy. Between 1979 and 1986, for example, the rate of increase in the CPI is still less than two-tenths of one percentage point higher on account of environmental expenditures. Moreover, increased environmental spending exerts an even more powerful stimulus to employment. In fact between 1980 and 1986, the unemployment rate is reduced by about 0.4 of a percentage point in the higher spending scenario. The added spending has an imperceptible effect on real GNP and its rate of growth.

COST ESTIMATES

Each year since 1971, CEQ has presented estimates of current and future expenditures for pollution abatement and other environmental quality measures. This year's estimates rely primarily on

Figure 12–3

Real Gross National Product With and Without Environmental Controls



Source: Data Resources, Inc., "The Macroeconomic Impact of Federal Pollution Control Programs: 1978 Assessment," submitted to U.S. Environmental Protection Agency and CEQ, January 29, 1979.

information supplied by the relevant regulatory agencies, principally EPA. For example, the estimates of air and water pollution control costs are based largely upon EPA's *The Cost of Clean Air and Water*.[14]

Following CEQ practice, estimates are provided below both for total pollution control expenditures and for incremental expenditures—those necessitated by federal legislation. In certain instances—mobile source pollution or control of toxic substances, for example—the estimates assume that no expenditures would have been made in the absence of federal legislation. In these cases, therefore, total and incremental expenditures are identical.

These estimates should be interpreted with care. In some respects they may underestimate, and in others exaggerate, spending for pollution abatement and environmental quality. Many of these uncertainties have to do with the projections for future spending.

Indeed, the most important reason for possible underestimation has to do with future regulations. The CEQ projections, extending 10 years into the future, include the effects only of regulations already issued or close enough to issuance that reasonable judgments about future costs can be made. Thus, for example, any costs resulting from future regulations to control toxic water pollutants or protect visibility in clean air regions are *not* included in this year's projections. Also, projections do not take into account the current revisions of State Implementation Plans or revisions of the National Ambient Air Quality Standards—but either of these might reduce as well as raise compliance costs; the 1979 revision of the ozone standard will, in fact, tend to reduce costs, because the standard was somewhat relaxed.

The estimates do not reflect any costs borne by the private sector as a result of delays or siting changes caused by environmental regulations. In some cases these costs might be significant. It is possible, however, that delays or location changes might redound to a firm's benefit as well as creating costs. Moreover, the CEQ estimates take no account of the possible effects of environmental regulation on technological innovation or on labor productivity. Here, too, the effects of regulation are ambiguous and difficult to identify, much less quantify. Nor do the CEQ estimates include any of the costs society may bear when a product disappears from the market or when a new product or chemical is not introduced because of environmental regulation. These welfare losses, as they are called, are real economic costs but are extremely difficult to estimate.

In some important respects, the CEQ estimates may exaggerate pollution control and environmental quality spending. The estimates of industrial compliance costs assume that firms will install specific kinds of control technology to meet standards. If, over time, a firm discovers a production process change enabling it to meet an air or water quality standard at less cost than the assumed technology, CEQ's projection will exaggerate compliance costs. Similarly, if new industrial sources of air or water pollution are less numerous than

projected, the compliance costs resulting from new source performance standards will be overstated. In these respects, the estimates presented here may be viewed as conservative, or higher than is realistic. The sooner new, innovative means of pollution control are introduced, the more the projections will overestimate future costs.

The projections also ignore EPA's continuing review of the BAT regulations for industrial discharges of conventional water pollutants. It appears that several of the standards that will result from this review may be less strict than existing BAT standards. Because the projections shown below are based on existing BAT standards, they will be high in this respect. Moreover, the estimates assume that firms and municipalities will adhere to the compliance schedules established by law. To the extent that these deadlines are ignored or relaxed, actual pollution control and environmental quality spending in future years is overestimated.

Moreover, there is some inevitable double counting of the costs of disposal of municipal solid wastes that cannot be burned because of air pollution laws. These expenditures are often entered both as costs of municipal air pollution control and as solid waste disposal costs. There is no way of knowing how serious this exaggeration of pollution control costs may be, but it could be significant.

Some solid wastes cannot be burned because of air pollution laws. Pollution control estimates may double count the costs of handling these wastes—once for air pollution control costs, and again for solid waste disposal costs.

It should be noted that certain investments in pollution control can be financed with tax-exempt bonds or can qualify for rapid depreciation. This will make the cost of pollution control to the firms involved less than CEQ has estimated. However, citizens still bear the full cost of pollution control, because the tax loss to the Treasury resulting from favorable tax treatment means higher income taxes or reductions in government programs.

This last point has general significance: *Regardless of their initial impacts, the costs of pollution control are borne by the citizens of the United States.* There are no disembodied entities called "industry" or "government" that really bear these costs. The final burden comes to rest on individuals. It is true that the incidence or the final burden among individuals will differ, depending on whether a cleanup effort is required of industry or undertaken by the government itself. In the case of industry, the burden might be borne by the stockholders of the affected firms, their management and employees, or consumers purchasing their products. If governments step in to clean up, the cost is borne by taxpayers, or by those who benefited from programs that are reduced or eliminated to make cleanup funds available. In either case, some of the same individuals may be affected. Nevertheless, citizens ultimately pay all the costs of pollution control.

Table 12–4 displays CEQ's estimates of incremental costs for the 10-year period 1978 through 1987. Total costs are presented in Table 12–5. Compliance cost estimates are presented for the control of: air pollution, due to the Clean Air Act as amended; water pollution, due to the Clean Water Act; solid waste disposal, due to the Resource Conservation and Recovery Act; toxic substance control, due to the Toxic Substance Control Act; drinking water protection, due to the Safe Drinking Water Act; noise pollution abatement, due to the Noise Control Act as amended; pesticide control, due to the Federal Insecticide, Fungicide, and Rodenticide Act as amended; and finally, the costs of land reclamation, arising from the Surface Mining Control and Reclamation Act. CEQ has included estimates for drinking water and pesticides for the first time this year.

The estimates indicate that the cost of complying with all existing federal pollution control and environmental quality programs in 1978 was $26.9 billion. Almost all of this cost was due to spending for air and water pollution abatement. Expenditures for federal air pollution programs totaled $16.6 billion in 1978 with $7.6 billion devoted to the control of mobile source air pollution (cars, trucks, buses, motorcycles, etc.) and another $5.0 billion for the control of air pollution from industrial point sources. Utilities, counted separately, were required to spend $2.8 billion for pollution abatement in 1978. Of the $16.6 billion in incremental costs for air pollution control in 1978, $7.5 billion was for capital costs, while $9.1 billion went to the operation and maintenance of air pollution control equipment.

Table 12–4

Estimated Incremental Pollution Abatement and Environmental Quality Expenditures, 1978–87 [a]

(billions of 1978 dollars)

	1978			1987			Cumulative (1978–87)			
	Operation and Maintenance	Annual Capital Costs [b]	Total Annual Costs	Operation and Maintenance	Annual Capital Costs [b]	Total Annual Costs	Capital Investment	Operation and Maintenance	Capital Costs [b]	Total Costs
Air Pollution										
Public	0.9	0.3	1.2	2.0	0.8	2.8	4.6	13.7	5.5	19.2
Private										
Mobile	4.3	3.3	7.6	5.1	9.3	14.4	59.6	45.0	66.4	111.4
Industrial	2.3	2.7	5.0	3.7	5.2	8.9	28.6	44.1	38.6	82.7
Utilities	1.6	1.2	2.8	6.5	4.8	11.3	26.4	37.5	28.1	65.6
Subtotal	9.1	7.5	16.6	17.3	20.1	37.4	119.2	140.3	138.6	278.9
Water Pollution										
Public	1.5	3.0	4.5	2.1	5.0	7.1	17.2	16.6	46.7	63.3
Private										
Industrial	2.1	1.6	3.7	5.7	4.6	10.3	28.0	38.9	30.4	69.3
Utilities	1.2	0.8	2.0	1.8	1.2	3.0	3.9	16.0	10.1	26.1
Subtotal	4.8	5.4	10.2	9.6	10.8	20.4	68.5	71.5	87.2	158.7
Solid Waste										
Public	NA	NA	NA	0.5	0.3	0.8	NA	3.5	2.2	5.7
Private	NA	NA	NA	1.2	0.6	1.8	NA	8.8	4.7	13.5
Subtotal	NA	NA	NA	1.7	0.9	2.6	NA	12.3	6.9	19.2
Toxic Substances	0.1	NA	0.1	0.3	NA	0.3	NA	2.2	NA	2.2
Drinking Water	<.05	<.05	<.05	0.4	0.4	0.8	NA	2.9	2.7	5.6
Noise	<.05	<.05	<.05	0.6	1.0	1.6	4.8	2.5	4.1	6.6
Pesticides	<.05	<.05	<.05	0.1	<.05	0.1	NA	0.4	<.05	0.4
Land Reclamation	NA	NA	NA	0.8	NA	0.8	NA	6.0	NA	6.0
Total	14.0	12.9	26.9	30.8	33.2	64.0	192.5	238.1	239. 5	477.6

NA = Not Available

[a] Incremental costs are those made in response to federal environmental legislation beyond those that would have been made in the absence of that legislation. [b] Interest and depreciation.

Table 12–5

Estimated Total Pollution Abatement and Environmental Quality Expenditures, 1978–87

(billions of 1978 dollars)

	1978			1987			Cumulative (1978–87)			
	Operation and Maintenance	Annual Capital Costs	Total Annual Costs	Operation and Maintenance	Annual Capital Costs	Total Annual Costs	Capital Investment	Operation and Maintenance	Capital Costs	Total Costs
Air Pollution										
Public	1.3	0.4	1.7	2.8	1.2	4.0	6.5	19.6	7.8	27.4
Private										
Mobile	4.3	3.3	7.6	5.1	9.3	14.4	59.6	45.0	66.4	111.4
Industrial	2.8	3.4	6.2	4.8	6.5	11.3	29.9	36.0	51.4	87.4
Utilities	2.2	1.6	3.8	7.5	5.5	13.0	32.4	45.5	34.0	79.5
Subtotal	10.6	8.7	19.3	20.2	22.5	42.7	128.0	146.1	159.6	305.7
Water Pollution										
Public	2.8	10.3	13.1	3.8	16.1	19.9	41.5	32.8	131.7	164.5
Private										
Industrial	2.7	2.0	4.7	6.8	5.2	12.0	34.7	48.5	36.8	85.3
Utilities	1.5	.9	2.4	2.4	1.5	3.9	6.3	19.9	12.2	32.1
Subtotal	7.0	13.2	20.2	13.0	22.8	35.8	82.5	101.2	180.7	281.9
Solid Waste										
Public	1.6	.3	1.9	2.5	.7	3.2	3.2	21.5	5.5	27.0
Private	3.9	.6	4.5	6.5	1.4	7.9	4.2	54.6	11.7	66.3
Subtotal	5.5	.9	6.4	9.0	2.1	11.1	7.4	76.1	17.2	93.3
Toxic Substances	0.1	NA	0.1	0.3	NA	0.3	NA	2.2	NA	2.2
Drinking Water	0.3	0.3	0.6	0.8	0.8	1.6	NA	6.4	6.1	12.5
Noise	<.05	<.05	<.05	0.6	1.0	1.6	4.8	2.5	4.1	6.6
Pesticides	<.05	<.05	<.05	0.1	<.05	0.1	NA	0.5	<.05	0.5
Land Reclamation	0.1	NA	0.1	1.0	NA	1.0	NA	8.0	NA	8.0
Total	23.6	23.1	46.7	45.0	49.2	94.2	249.5	343.0	367.7	710.7

NA = Not Available

Of the $10.2 billion spent in response to existing water pollution control laws in 1978, about half was spent by government (primarily for municipal wastewater treatment) and the other half by industry and utilities. Capital costs accounted for $5.4 billion of the $10.2 billion with the other $4.8 billion going to operation and maintenance.

The $26.9 billion in total incremental spending in 1978 was about 1.3 percent of GNP in that year and about $120 per person. This is comparable to previous estimates, but slightly higher.

As shown in Table 12–4, the estimates indicate that by 1987 annual incremental spending will total $64.0 billion. Although air and water pollution control will continue to increase in absolute terms, their relative share in the total will fall. According to the estimates, by 1987 toxic substances control, solid wastes disposal, noise control, and other environmental quality costs will account for 10 percent of all incremental spending, with air and water pollution control accounting for the other 90 percent.

Over the 10-year period from 1978 to 1987, total incremental spending in response to all federal environmental programs is projected at $477.6 billion. Of this amount, $278.9 billion will be spent in response to existing federal air pollution regulations, $158.7 billion on account of existing water laws, and another $40 billion due to solid waste, noise, and other environmental quality legislation.

ECONOMIC INCENTIVES AND ENVIRONMENTAL PROTECTION

It appears from the evidence presented above that the benefits resulting from environmental quality improvements are quite substantial. Nevertheless, the resources devoted to pollution control are not inconsiderable. Thus, it is reasonable to ask whether the nation's environmental goals might be met in a less expensive manner. If so, resources can be released to build schools, improve bus systems, support the local symphony, or reduce taxes, while environmental quality standards are maintained.

This is what "cost-effectiveness analysis" is all about—finding ways to accomplish a well-defined goal or set of goals in the least expensive way possible. Conversely, it can mean squeezing the most environmental protection from a given budget. Either way, it makes good sense in environmental or any other kind of policymaking.

Is there much latitude for cost-effectiveness analysis in environmental policy? Economists have been quick to answer "yes." They suggest that the nation modify the set of economic incentives faced by polluters—private firms, governments, and citizens alike—in such a way that environmental protection flows naturally from self-interest. If this is done, economists claim that the nation can reduce the cost of environmental protection, while still enjoying its benefits.

CEQ's estimates of pollution control costs include the costs of controlling toxic substances, regulating surface mining of coal, and reclaiming the land afterward. Photographer: M. Woodbridge Williams (above); John Messina (below).

Discussed below are the two most common forms of economic incentives—an effluent charge and a marketable pollution permit. The general strengths and weaknesses of economic incentive approaches are described, followed by a brief discussion of a recent study that deals with the possible role of economic incentives in controlling emissions of nitrogen oxide (NO_x). Several recent "real world" applications of economic incentives in environmental policy conclude the chapter.

The approach taken in the nation's current air and water pollution programs is regulatory in nature: the law allows air or water polluters to discharge only certain specified amounts of particular pollutants into the ambient environment. Industrial plants must obtain permits to discharge the allowable quantities of pollutants and it is the responsibility of EPA and the states to insure that they are not violating the terms of their permits.

The nation's water pollution control strategy was established in the 1972 amendments to the Federal Water Pollution Control Act (now usually called the Clean Water Act). Under this law, for the first time, federal effluent standards (or limitations) were imposed on individual private discharges and a permit system established. Goals, with accompanying deadlines, were also established for publicly owned waste treatment facilities, and enforcement procedures were strengthened and linked to the discharge limitations and the permit-granting process.

This overall approach grew out of frustration with previous legislation, which established ambient water quality standards for interstate waters, but left the means of attaining these standards to the states. The old approach had failed, in the eyes of Congress, mainly because it was neary impossible to link any individual's discharges to diminutions in ambient water quality. This in turn made it virtually impossible to enforce the limitations imposed on individual dischargers by the states.

The Clean Air Act of 1970 provides for a slightly different approach to air pollution control. New sources of air pollution were required to meet specific emission standards, which has had the effect of requiring them to adopt particular technologies. But rather than prescribe limits on the air pollutants emitted by existing sources—individual factories, power plants, or stationary sources—the Clean Air Act directed EPA to establish national primary and secondary ambient air quality standards for six major pollutants. The individual states were then directed by Congress to prepare plans to assure EPA that these standards would be met according to the schedule established by Congress. In addition, the Clean Air Act called for strict limitations on emissions from mobile sources of hydrocarbons, carbon monoxide, and nitrogen oxides.

This general approach to pollution control is quite similar to the way in which other socially offensive activities are regulated. First, it is decided how much of a particular activity will be tolerated; next, that is established as the maximum permissible level (for crimes,

that level is zero); then compliance with the standard is monitored and those in violation are penalized. Broadly speaking, this approach has worked well and probably will continue to form the basis of the nation's regulatory activities, including environmental regulations, for some time to come.

Yet, in theory at least, this standards-and-enforcement approach denies an opportunity for cost savings, savings that might be realized if economic incentives were used as tools of environmental policy.

To understand the deficiency in the regulatory approach, consider the establishment of effluent limitations. Generally, EPA requires all dischargers within a broad class to reduce the pollution they discharge by the same percentage. EPA, however, recognizes variations in treatment costs among industries and even among some firms in the same industry. If there are differences in pollution control costs between firms—and there generally are—it is uneconomical to require of all an identical cutback in pollution. The same total reduction in wasteload could be effected at less cost by requiring the largest cutback of those firms that can do so most cheaply. For example, certain firms can easily modify their production processes or substitute "cleaner" inputs for those they currently use. If these firms were assigned the majority of the cleanup burden while others, less able to eliminate discharges, were required to do less, the total reduction could be accomplished for less.

Inefficiencies of this kind are tolerated for several reasons, the most important being the appearance of equity. Is it not fair to require all polluters to cut back by 20 percent if total discharges are to be cut by that percentage? The answer is "not necessarily," if some firms will find that cutback easy, while others may be bankrupted by it. In pollution control, questions of equity are not always clear or easy to answer.

Another potential source of inefficiency is the de facto requirement that new sources of air or water pollution install specific technology to abate their pollution. After all, the ultimate goal of air and water pollution laws is the protection of the environment. Whether done by installing scrubbers or electrostatic precipitators, or by changing production processes or input mixes—substituting low- for high-sulfur coal, for one example—should not matter. Yet technology-based standards do not allow firms to use certain of these methods for meeting ambient or performance standards, even though such methods may occasionally be relatively inexpensive. Instead, they can condemn the nation to spend more to meet its environmental goals than is necessary.

Effluent charges and marketable permits are the two forms of economic incentives that have received the most attention when alternative kinds of environmental policy are considered. In principle, both save money, but in practice it may not always be possible to reap all the savings these methods appear to offer. Nevertheless, they clearly have attractions.

With an effluent charge, air or water polluters would be free to discharge at will, subject to the very important proviso that they pay a predetermined fee for each and every unit of pollution so discharged. This charge then creates a clear inducement for polluters to discover "cleaner" methods of production, an inducement that grows stronger the higher the per-unit effluent charge is set. For every pound or gallon of effluent eliminated in production, that much less is paid in pollution charges. The key and distinguishing feature of such an approach is the latitude it allows dischargers: they can continue to pollute, and pay to do so, or elect to undertake clean-up efforts.

Clearly, those firms that can eliminate a pound of pollution for less than the tax they would pay for discharging it will clean up. Not to do so would cost them money. Those firms finding it more expensive to eliminate discharges will continue to pollute, paying the per-unit charge. They will be acting in their own economic interest in the process, yet under a system that forces them to internalize certain costs that were previously borne externally by society. The effluent charge should offer these firms a strong and continuing incentive to discover inexpensive ways to abate pollution. For if such methods are discovered, they will permit the firm to escape the burden of the effluent charge.

Even this simple account highlights one inherent advantage of such an incentive system: the firms reducing their pollution when confronted by an effluent charge share one characteristic—they find it less expensive to eliminate pollution than to pollute and pay the charge; those continuing to pollute—and pay for it—share the opposite trait.

Hence, the firms that elect voluntarily to eliminate pollution are the "low-cost" firms—exactly the ones that would be ordered to cut back under a regulatory system designed to minimize the cost of environmental protection. The automatic character of this result under an effluent-charge system is the system's most desirable feature. When there are great differences in abatement costs between polluters, considerable savings might accrue to society from an effluent charge system, as compared to requiring identical percentage reductions from all polluters.

Another variant of the economic incentive approach—the marketable rights or permit system—suggests similar possibilities for economy in pollution control. Under this approach, a pollution control authority would first determine the maximum permissible total discharge of a pollutant. Then, permits to discharge some fraction of this total would be printed and auctioned off. The firms most likely to purchase the permits would be those whose production necessitates a certain amount of pollution. Yet nothing would prevent individuals or groups who value clean air or water highly from buying up the permits and holding them idle. At any rate, only those holding permits for pollutants (SO_2, NO_x, etc.), would be allowed to discharge them, and enforcement would proceed in much the same way

as it does under the current regulatory system. Firms could buy permits either in the original auction or could repurchase them from other firms or individuals who had acquired permits in the auction.

The pollution rights would be highly valued—no permit, no pollution. Therefore, firms would have an incentive to search for pollution-free methods of production to avoid the cost of acquiring expensive permits. Firms that could reduce or eliminate pollution for less than the cost of permits would do so, while those that could not would continue to buy them. Thus, in the same way as effluent charges, a marketable permit approach tends automatically to obtain reductions from the low-cost abaters and, in the process, minimizes the social cost of pollution control.

A lively debate goes on between those favoring these two variants of an economic incentive approach to pollution control. The marketable permits approach, its proponents argue, has several advantages over charges: first, permits are more in keeping with the spirit of existing legislation where discharge permits, though currently nonmarketable, are already required. Second, under a marketable permits approach, the total amount of pollution is fixed by the number of permits. Thus, the nation would be assured that pollution would not exceed the permitted level (assuming enforcement is effective). This contrasts with an effluent charge approach where only the per-unit price of pollution is controlled. Under such an approach, a miscalculation of polluters' responses to the level of the charge could result in a dangerously high level of pollution until the level of the charge is adjusted. Finally, the marketable-rights approach can more readily accommodate economic growth at no loss to environmental quality. Because new firms can buy up existing rights from less productive firms, environmental quality is maintained. Under a charge system, however, new firms would pay the existing charge, but this could result in more pollution than the air or water could safely bear until the charge is increased.

Charges appear to be superior to permits in one interesting respect, however. Consider a possible transition from the current regulatory approach to either an effluent-tax system or a marketable-permits system. If the effluent charge is adopted, firms have an incentive during the transition period to begin to reduce pollution so that they will be paying less when the charge takes effect. But if a marketable-permits system is to be set up, and if firms are to be permitted to sell off their existing levels of pollution, they may *increase* their pollution in the interim so that they will have more pollution to "sell" to new firms wanting to pollute.

A more important debate concerns the ability of both incentive systems to deliver what they promise. Theoretically, these systems work beautifully; however, practically, there are potential problems. Among the hard questions to be answered about economic incentives as actual tools of environmental policy are the following:

- How great are the savings such systems might actually provide? Are treatment costs among polluters really so very different? Cannot the existing regulations differentiate among such sources when limits are assigned under the standards-and-enforcement approach?
- How difficult is it to set a just charge that accurately reflects pollution costs and thereby achieves the desired level of water or air quality? How will polluters actually respond to charges at various levels? What would be the effect of varying the charge suddenly if it was discovered to be too high or low?
- Do adequate source-monitoring devices exist so that it can be determined whether a polluter is paying his appropriate effluent charge? (Note that accurate monitoring is required under a standards-and-enforcement approach, as well.) Could marketable permits be purchased as a tool to drive competitors out of business? Could polluters form a cartel to keep the price of pollution permits artificially low?

ECONOMIC INCENTIVES AND A SHORT-TERM STANDARD FOR OXIDES OF NITROGEN

In the 1977 amendments to the Clean Air Act, Congress expressed a new but still cautious interest in the economic incentive approach to environmental policy. This interest was most clearly reflected in Section 405 of the amendments, which called for several studies "concerning economic approaches to air pollution," including one on the applicability of economic penalties for controlling emissions of oxides of nitrogen from stationary sources. Such a study was undertaken for CEQ, EPA, and the Council of Economic Advisers and completed during the year.

Using data on 797 individual stationary sources in the Chicago Air Quality Control Region, the study examined the cost and effectiveness of a variety of strategies that could be used to meet a *hypothetical,* short-term standard for nitrogen dioxide of 250 micrograms per cubic meter ($\mu g/m^3$). (It is important to note that no short-term standard has yet been proposed for nitrogen dioxide.) The study concluded that both effluent charges and marketable permits would, if appropriately designed, meet and maintain the hypothetical ambient standard at lower cost than would a regulatory approach. It also concluded that while the practical problems of implementing a policy based upon economic incentives are not to be minimized, they are not insurmountable. According to the study, both emissions charges and marketable emission permits could be implemented using only currently available legal and administrative measures.

Another important finding of the study is that policies that take account of differences in control costs between sources will reduce the cost of attaining ambient standards. The source-by-source approach will pay off, regardless of whether the control policy is based

on economic incentives or on regulations. However, the study argues the savings tend to be greatest with economic incentive policies. For this reason, the study concludes that incentive policies are the best approach.

The strategies studied were: a "baseline" in which no stationary source controls are applied; "RACT" (reasonably available control technology), in which all sources install currently available and economically affordable pollution control equipment; a highly sophisticated "least cost" strategy, in which emissions reductions are assigned individual sources depending upon both the cost of emissions control at each source and the contribution of emissions from each source to ambient concentrations of nitrogen dioxide; "selective emissions control," a relatively sophisticated approach establishing nine classifications for emitters of nitrogen dioxide, based on control costs, and requiring all firms within each classification to reduce emissions by the same percentage (the largest reductions being required of the sources in the low-cost classifications); "simple rollback," a crude approach in which all stationary sources of nitrogen dioxide reduce emissions by an identical percentage; and "maximum feasible control," in which all sources install the most advanced control equipment available regardless of its cost. A control strategy of "uniform charges" was also considered but not fully analyzed in the study.

The results of the study are presented in Table 12–6 where the effectiveness of each strategy is measured by the number of sources that must install pollution controls, number of pounds of nitrogen dioxide removed, and the number of receptors (monitoring stations) in violation of the standard. In the fourth column are reported estimates of the annual control costs associated with each strategy—that is, what is would cost to purchase, operate, and maintain the pollution control equipment for all the controlled sources.

As Table 12–6 indicates, the variation between the strategies in the estimated costs of meeting the hypothetical standard is substantial. Either maximum-feasible control or a simple 90 percent rollback from all sources would impose control costs on sources (and ultimately on society) of $254 million annually. This is 12 times more expensive than meeting the same standard using the least-cost strategy, 11 times more expensive than RACT, and nearly 3 times as costly as selective emissions control. Put in another way, according to the study the nation could save an estimated $230 million in annual control costs by using a least-cost strategy rather than a maximum feasible control strategy to meet the hypothetical standard. This estimate is for a single air quality control region and a single, hypothetical air quality standard. The potential for such savings on a national basis, over a number of standards, accounts for the attention economists have devoted to alternative means of pollution control.

The effectiveness of each strategy is also indicated in the table. Note that by concentrating emission reductions on a relatively small

Table 12–6

Cost and Effectiveness of Pollution Control Strategies for Nitrogen Dioxide

Control Strategy	Number of Sources Controlled	NO_x Emissions Removed (thousand lb/hr)	Number of Receptors in Violation	Annual Control Cost (million $/yr)	Average Dollar Cost of Removing (lb/hr)
No control baseline	0	0	104	0	0
RACT	797	37	80	23	622
Least cost	96	5	0	21	4200
Selective emissions control	741	39	0	94	3240
Simple rollback					
90 percent	797	106	0	254	2400
80 percent	792	104	6	243	2340
Maximum feasible control	797	106	0	254	2400
Uniform charges	790	105	0	239	2280

Source: Adapted from *An Analysis of Alternative Policies for Attaining and Maintaining a Short-Term NO_2 Standard*, prepared for CEQ, EPA, and CEA by Mathtech, Inc., 1979, pp. 5–23.

number of "key" sources, the least-cost strategy controls only about one-seventh the number of sources controlled by any of the other approaches. In terms of simplicity, then, it looks good. However, because the least-cost strategy is designed only to meet the short-term standard and nothing more, it results in the removal of considerably fewer pounds of nitrogen dioxide (5000 lb/hr) than any of the other strategies. For example, selective emissions control would remove 29,000 pounds per hour, or about six times as much as the least-cost strategy. Note also that two of the strategies considered, RACT and 80 percent rollback, would not bring all 270 monitoring receptors into compliance with the standard, although the latter would come close. This, too, must be considered in judging the effectiveness of the strategies.

Column 5 of Table 12–6 puts the strategies in a slightly different light, by showing the average annual cost of removing a pound of nitrogen dioxide per hour (column 4 divided by column 2). Measured against this criterion, the "least-cost" strategy appears to be the most expensive of all those considered. In explanation, it must be re-emphasized that the least-cost strategy *is* the least expensive way of guaranteeing that the hypothetical short-term standard will be met at all monitoring receptors. That is the goal to which the costs in the fourth column refer. The other strategies, by failing to concentrate on the "worst offenders," involve the removal of considerably more pounds of nitrogen oxides to meet the same standard. Yet in one case they do so at only slightly higher total cost than the least-cost strategy, so it is not surprising the least-cost strategy is *not* the highest ranked on a cost-per-pound basis. If the goal were to remove a fixed number of pounds of nitrogen dioxide for as little

as possible, a different least-cost strategy would exist and would concentrate reductions on those sources that could reduce their discharge at the lowest per pound cost.

One very important question remains to be answered. Can an economic incentive approach, using either effluent charges or marketable permits, bring about the reductions— and the cost savings—associated with the "least-cost" strategy? The study concludes that it can. However, the study also concludes that the design of an effluent charge system is highly important to this conclusion. If, for some reason, the ideal system of effluent charges cannot be applied, some other system of charges may not capture many, or indeed, any of the cost savings associated with the ideal set of charges.

To illustrate this, the study points out that the ideal set of charges will include some very stiff charges on certain sources of nitrogen dioxide and much lower charges on others, depending on differences in source control costs as well as differences in the contributions of each of the sources to violations of the standard. The variation in charge levels can be considerable under the ideal system. For example, one industrial oil-fired boiler would face a charge of $62 per pound of pollution per hour while another boiler would face a charge of $43,633—more than 700 times greater. Although the range of charges is narrower for industrial coal-fired boilers and for sources of industrial process heat, the difference between the highest and lowest charge is at least one order of magnitude.

What if it is not possible to levy very different charges on different sources, even if there is a valid economic reason for doing so? For example, suppose political pressures dictated that only a set of uniform charges could be adopted, in which each stationary source would face the same charge of $25,000 per pound of nitrogen oxides discharged per hour (the lowest uniform charge consistent with attainment of the standard)? In this case, as the last line in Table 12–4 indicates, the estimated annual cost of control soars to $239 million. This is almost as much as the costs incurred under the maximum feasible control strategy. In addition, 790 of the 797 sources would have to install controls. Hence, while effluent charges offer the possibility of substantial cost savings and ease of administration, the realization of those advantages depends critically on the specific set of charges the authority is empowered to levy.

It should not be concluded, however, that a uniform charge approach is inferior on grounds of cost-effectiveness to all regulatory approaches. The practical constraints that may make it difficult to implement a source-by-source charge may also make it difficult to implement a source-by-source regulatory policy. The regulatory approach actually adopted might closely resemble simple rollback.

Even if the effluent charge and regulatory policies operate under similar practical constraints, there are still good reasons to prefer a policy based on charges. In the presence of uncertainty, an economic incentive approach will in general yield lower costs, will provide

continuous impetus to environmental improvement, and will continually stimulate the development and application of new, low-cost, effective abatement technology.

A considerable amount of information would be required to implement the least-cost strategy. The authority responsible for setting the charges or effluent limits would need detailed data on the cost of reducing emissions at each source, as well as data on the likely contribution of each source to violation of the ambient standard at any monitor. In addition, the ideal set of charges or standards would have to be adjusted over time to account for inflation, economic growth, and technological change.

The study also examines a marketable permit system. Like effluent charges, marketable permits are found to be capable of achieving the least-cost reductions. However, the report argues that permits can do so without many of the problems that accompany an ideal effluent charge or regulatory system. The market price of permits would automatically rise with the general level of prices, thus obviating the need for adjustments for inflation, economic growth, and technological change. More importantly, very little of the detailed source-by source information required to implement the least-cost strategy via effluent charges or standards is necessary for the marketable permits system. Recognizing that many details of the marketable permit approach remain to be ironed out, the study recommends that this approach be given careful consideration.

ECONOMIC INCENTIVES IN THE REAL WORLD

In several places, this chapter has discussed in the abstract economic incentives as tools of environmental policy. These approaches are not entirely theoretical. In fact, economic incentive approaches are currently being used or seriously considered at the state and federal levels.

EPA's "bubble concept" is a modest attempt to incorporate such an approach. Under this policy, EPA has encouraged states to allow increases in air pollution from one or more sources at a single plant as long as equivalent reductions in emissions are accomplished at other sources in the same plant. It is as if a bubble covered the entire plant from which pollution emanated at but a single point. As long as the total emissions escaping the bubble remain constant, it makes sense to allow the plant to control emissions at the sources where it can be done inexpensively in exchange for increased emissions at the sources where control would be expensive. In other words, although total pollution from the plant remains constant, pollution abatements costs are reduced for the firm and, indirectly, for society. The bubble concept simulates a marketable permit system in which one source in a plant "purchases" a right to increase emissions by securing an offsetting reduction elsewhere in the plant.

Among the qualifications to the policy are: reductions in one class of pollutants cannot be "swapped" for increases in another class, especially toxic pollutants; all pollution from a plant cannot be "loaded" on one source in such a way that air quality standards are violated; and the concept cannot be used as an excuse to delay compliance with current air quality standards. If these qualifications can be met, use of the bubble concept will make source savings in air pollution abatement costs possible.

The bubble is currently being applied to air pollution only. Although there are some special difficulties associated with its use in water pollution control, these can be overcome. In view of the savings that might result, a speedy application of the bubble to water pollution is desirable.

A much more ambitious use of economic incentives is EPA's so-called "offset policy," which was a response to a dilemma created by the Clean Air Act. Under the nonattainment provisions in the Act, new growth in areas already in violation of the primary air quality standards appeared to be prohibited. In order to circumvent this problem, EPA proposed that new sources seeking to locate in nonattainment areas, or existing sources wishing to expand, be allowed to do so provided they obtained offsetting reductions in air pollution from existing sources. This means a new plant that would be a source of SO_2 could move into an area currently in violation of the SO_2 ambient air quality standard if it could induce existing SO_2 sources in that area to undertake equivalent or greater reductions. Similarly, an existing plant could add new sources of pollution as long as it reduced its own pollution elsewhere or induced some other polluter to cut back.

This policy did not result from fundamental dissatisfaction with the current regulatory approach; nor did it arise because the beauty of the economic incentives approach cried out for adoption. Rather, the offset policy was an attempt to circumvent one problem posed by regulation. Nevertheless, it does offer some of the advantages of a full-fledged marketable-permit-approach and may represent the first of a number of such uses.

Consider the decision faced by existing polluters in a nonattainment area. If a new plant wishes to locate in the area, the newcomer must come to existing polluters and offer to compensate at least one of them for reducing its discharge of the pollutant(s) the new firm wants to emit. If the existing firm can reduce its discharges for less money than the new firm is willing to offer, it will do so and make money in the process. This deal also implies that the new firm cannot eliminate the pollutant for less money than it offers others—if it could, of course, it would not buy an offset. Hence, in the same way as discussed above, the creation of a market for pollution—and reductions in pollution—insures that effluent reductions will be undertaken by those who can do so most cheaply. In this way, any given level of environmental quality will be maintained at the least social cost.

The offsets market does not operate in quite the same way as would a marketable permits system. First, so that air quality will be improved in nonattainment areas, new sources are required to buy up more existing emissions than they themselves will be discharging. This guarantees that growth will be coupled with *improvements* in air quality, rather than deterioration or maintenance of the unsatisfactory status quo. Second, existing pollution can only be "bought off" by new sources or existing sources wishing to expand. That is, individuals wishing to eliminate pollution by buying up and retiring existing emissions can only do so through private arrangements, not as a part of a state implementation plan. Also, existing sources cannot yet voluntarily eliminate and "bank" their emissions in anticipation of a future sale, although EPA is encouraging states to develop rules under which such banking might be permitted.

In spite of these restrictions, the offset policy is clearly the most ambitious attempt to capture some of the advantages offered by economic incentive approaches. As of March 1, 1979, there had been 115 transactions between firms seeking offsets and either firms or governmental units willing to offer reductions. Of 45 cases examined in detail, 60 percent of the transactions involved hydrocarbon offsets, 7 percent sulfur dioxide, and 31 percent particulates. The large majority of new sources desiring offsets have been firms expanding existing plants.[15]

Efforts to use incentives in environmental policy are not confined to the federal level. Currently under consideration by the Wisconsin Department of Natural Resources is a proposal to use marketable permits to allocate discharges of both phosphorus and biochemical oxygen demand (BOD) on that state's Fox River. Preliminary calculations indicate that such a proposal could produce substantial cost savings.[16]

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APPENDIX A

ENVIRONMENTAL STATISTICS *

* Many of these tables have been updated from *Environmental Statistics, 1978,* prepared by the Center for Environmental Reporting and Sigma Data Computing Corp. for the Council on Environmental Quality, the Environmental Protection Agency, and the Department of the Interior, U.S. Geological Survey, Resources and Land Investigations Program.

Table A–1

Post-Consumer Municipal Solid Waste Discarded, Recycled, and Disposed of, 1960–77

	1960	1965	1970	1971	1972	1973	1974	1975	1976	1977
Total gross discards:										
Million tons per year	87	105	131	133	139	143	143	136	143	148
Pounds per person per day	2.64	2.96	3.50	3.52	3.65	3.72	3.70	3.49	3.64	3.74
Less resources recylced: *										
Million tons per year	6	6	8	8	9	10	10	9	11	12
Pounds per person per day	0.18	0.17	0.21	0.21	0.24	0.26	0.26	0.23	0.28	0.30
Equals net waste disposed of:										
Million tons per year	81	99	123	125	130	133	133	127	132	136
Pounds per person per day	2.46	2.79	3.29	3.31	3.41	3.46	3.44	3.26	3.36	3.44

* Includes material and energy. Post-consumer solid waste includes residential and commercial solid waste. Excludes wastewater treatment sludge (about 5 million dry weight tons/year), discarded autos and building demolution residues (about 45 million tons/year), and street sweepings.

Source: (1960–1970, 1977) Franklin Associates, Ltd., "Post-Consumer Solid Waste and Resource Recovery Baseline," prepared for the Resource Conservation Committee, April 6, 1979, Table 1, p. 9; (1971–1976) U.S. Environmental Protection Agency, Office of Solid Waste, unpublished data.

Table A–2

Material Recycled From Post-Consumer Municipal Solid Waste, by Type, 1960–77

(in thousands of tons)

Material Recycled	1960	1965	1970	1971	1972	1973	1974	1975	1976	1977
Paper and paperboard	5,575	5,870	7,116	7,330	7,623	8,867	9,652	7,853	9,356	10,180
% of gross paper and board discards	18.9	15.9	16.1	16.3	15.7	17.6	19.6	18.6	19.4	20.7
Aluminum	0	0	9	18	27	34	52	90	106	140
% of gross aluminum discards	0.0	0.0	1.1	1.2	2.9	3.3	4.7	8.2	8.5	10.0
Ferrous metals *	50	100	150	176	202	210	225	238	258	285
% of gross ferrous discards	0.5	1.0	1.2	1.5	1.7	1.7	1.8	2.0	2.2	2.4
Glass	100	100	157	220	275	305	325	370	480	500
% of gross glass discards	1.4	1.2	1.3	1.8	2.1	2.2	2.3	2.7	3.4	3.4
Rubber (including tires and other)	330	327	254	257	245	220	194	189	120	160
% of gross rubber discards	18.0	14.0	9.7	9.1	7.9	6.7	6.1	6.9	4.1	5.0
Total materials	6,055	6,397	7,686	8,001	8,372	9,636	10,448	8,740	10,320	11,265
% of gross nonfood product waste	11.0	9.7	9.2	9.4	9.3	10.3	11.2	10.3	11.3	11.3
% of total post-consumer waste	7.0	6.1	5.9	6.0	6.0	6.7	7.3	6.4	7.2	7.4

All data exclude energy recovery.

* The Environmental Protection Agency has characterized the data for ferrous metals as highly inferential and preliminary.

Source: (1960–1970) Franklin Associates, Ltd., "Post-Consumer Solid Waste and Resource Recovery Baseline," prepared for the Resource Conservation Committee, April 6, 1979, pp. 11, 21; (1971–1975) U.S. Environmental Protection Agency, *Resource Recovery and Waste Reduction*, Fourth Report to Congress, SW-600, (Washington, D.C.: U.S. Government Printing Office, 1977), Table 6, p. 19, and previous annual issues; (1976–1977) U.S. Environmental Protection Agency, Office of Solid Waste, unpublished data.

Table A–3

Solid Waste Disposed of by Manufacturing Industry, 1974–77

(in thousands of short tons) [a]

SIC Code [b]	Manufacturing Industry	1974	1975	1976	1977
	Total, manufacturing	133,324.8	139,050.8	156,825.9	159,954.2
28	Chemicals and allied products	38,154.6	38,695.2	50,281.9	55,719.2
33	Primary metal industries	40,799.9	42,707.6	42,352.8	41,744.9
20	Food processing	11,500.6	12,640.8	14,965.3	13,087.8
32	Stone, clay, glass products	9,336.8	11,344.8	11,088.4	12,616.5
26	Paper and allied products	8,837.1	9,123.0	10,146.3	10,647.6
24	Lumber and wood products	6,886.8	8,142.7	9,328.0	6,310.5
37	Transportation equipment	4,207.1	3,784.6	4,283.5	4,748.9
35	Machinery, except electrical	2,713.7	2,719.7	3,066.9	3,580.7
29	Petroleum and coal products	2,387.5	2,037.6	2,592.4	2,873.1
34	Fabricated metal products	2,127.0	1,932.7	2,089.2	1,951.4
30	Rubber, miscellaneous plastic products	1,704.4	1,404.1	1,676.4	1,567.0
36	Electric, electronic equipment	1,533.5	1,500.0	1,500.3	1,495.3
27	Printing and publishing	617.2	627.9	848.2	940.9
22	Textile mill products	749.5	668.2	671.2	825.1
25	Furniture and fixtures	516.9	591.8	637.5	667.9
38	Instruments, related products	552.2	408.6	396.2	418.1
31	Leather and leather products	223.4	221.3	385.3	291.2
39	Miscellaneous manufacturing industries	318.6	349.9	351.6	335.3
21	Tobacco products	148.0	150.2	164.3	135.6

Data include solid wastes properly disposed of by means acceptable to local, state, and federal authorities. Recovered materials are excluded.

[a] The aggregated data are composed partially of wet weight and partially of dry weight figures.
[b] Standard Industrial Classification code.

Source: U.S. Bureau of the Census, *Pollution Abatement Costs and Expenditures, 1977*, Current Industrial Reports MA–200 (77)–2, (Washington, D.C.: U.S. Government Printing Office, 1977), Table 4A, and previous annual issues.

Table A–4

U.S. Pesticide Production [a] by Type, 1950–77

(In thousands of pounds)

Year	Synthetic Organic Pesticides, Total	Herbicides	Insecticides [b]	Fungicides
1950	286,000	N.A.	N.A.	N.A.
1951	463,998	49,409	318,762	95,827
1955	506,376	N.A.	N.A.	128,628
1960	647,795	102,472	366,224	179,099
1961	699,699	120,953	411,100	167,646
1962	729,718	150,888	461,351	117,479
1963	763,477	174,527	477,886	111,064
1964	782,749	226,386	443,660	112,703
1965	877,197	262,924	490,439	123,834
1966	1,013,110	323,692	552,012	137,406
1967	1,049,663	409,447	495,804	144,412
1968	1,192,360	468,992	569,205	154,163
1969	1,104,381	393,306	570,522	140,553
1970	1,034,075	403,784	490,132	140,159
1971	1,135,717	428,512	557,710	149,495
1972	1,157,698	451,311	563,575	142,812
1973	1,288,952	495,819	639,169	153,964
1974	1,417,158	604,152	650,209	162,797
1975	1,603,016	788,030	659,621	155,365
1976	1,364,391	656,045	566,084	142,262
1977	1,387,519	674,208	570,034	143,277

N.A.—Not Available.

[a] Production data include the total quantity of a commodity made available by the original manufacturers only. Production excludes intermediate products in the manufacturing process.

[b] Insecticides include fumigants, rodenticides, and soil conditioners.

Sources: International Trade Commission, *Synthetic Organic Chemicals*, annual issues.

Table A–5

Production of Organochlorines, 1950–78

(in thousands of pounds)

Year	Vinyl Chloride (1)	Chloroform [a]	PCBs [b]
1950	249,532	20,285	N.A.
1955	528,605	40,396	N.A.
1960	1,036,989	76,426	37,919
1961	1,043,983	77,315	36,515
1962	1,311,489	98,209	38,353
1963	1,435,209	105,149	44,734
1964	1,614,981	119,210	50,833
1965	2,000,000	152,510	60,480
1966	2,499,549	178,953	65,849
1967	2,423,572	190,886	75,309
1968	2,968,897	180,795	82,854
1969	3,735,942	216,168	76,387
1970	4,040,234	239,893	85,054
1971	4,335,782	230,766	40,471
1972	5,088,511	234,677	38,600
1973	5,351,056	252,786	42,178
1974	5,621,191	301,787	41,118
1975	4,196,250	261,740	29,710
1976	5,676,895	291,855	29,592
1977	5,985,912	301,526	13,330
1978	N.A.	N.A.	0

N.A.—Not Available.

[a] Vinyl chloride and chloroform production data include the total quantity of a commodity made available by the original manufacturers only. Production excludes intermediate products in the manufacturing process.

[b] PCB production includes only that produced for domestic sales.

Sources: Vinyl chloride and chloroform: International Trade Commission, *Synthetic Organic Chemicals*, annual issues. PCBs: (1960–1971) Interdepartmental Task Force on PCB's, *PCB's and the Environment*, (Springfield, Va.: National Technical Information Service) Com-72-10419, March 1972, pp. 6, 7; (1972–1978) Monsanto Company, unpublished data.

Table A–6

Production [a] of Other Industrial Chemicals, 1950–77

(in millions of pounds)

Year	Benzene [b]	Acrylonitrile	Asbestos [c] (primary demand)	Phthalates
1950	1,340.0	N.A.	N.A.	142.6
1955	2,247.7	117.9	1,564	212.8
1960	3,343.0	229.2	1,418	344.7
1961	3,986.7	249.5	1,332	376.5
1962	3,994.2	360.1	1,452	470.0
1963	4,732.6	455.3	1,448	521.9
1964	5,338.0	594.2	1,626	601.4
1965	6,044.7	771.6	1,590	678.7
1966	6,983.0	716.1	1,610	754.5
1967	7,085.9	670.8	1,442	783.9
1968	7,311.0	1,021.0	1,634	840.6
1969	8,664.9	1,156.6	1,568	883.8
1970	8,286.0	1,039.3	1,468	855.1
1971	7,864.9	978.9	1,518	978.2
1972	9,155.4	1,114.7	1,618	1,145.7
1973	10,623.3	1,354.2	1,752	1,203.1
1974	10,879.2	1,411.7	1,634	1,207.3
1975	7,484.8	1,214.6	1,206	903.8
1976	10,418.4	1,517.8	1,452	1,042.9
1977	10,495.3	1,646.0	[d] 1,362	[d] 1,202.4

N.A.—Not Available.

[a] Production data for benzene, acrylonitrile, and phthalates include the total quantity of a commodity made available by the original manufacturers only. Production excludes intermediate products in the manufacturing process.

[b] Benzene data converted from gallons to pounds using a conversion factor of 7.31 pounds/gallon.

[c] Primary demand for asbestos is the amount of new materials entering use.

[d] Estimated.

Sources: Benzene, Acrylonitrile, Phthalates: International Trade Commission, *Synthetic Organic Chemicals*, annual issues; Asbestos: (1954–1971) U.S. Department of the Interior, Bureau of Mines, *Mineral Facts and Problems* (Washington, D.C.: U.S. Government Printing Office, 1975), p. 120; (1972–1975) U.S. Department of the Interior, Bureau of Mines, *Commodity Data Summaries 1977* (Washington, D.C.: U.S. Government Printing Office, 1977), p. 12; (1976–1977) U.S. Department of the Interior, Bureau of Mines, unpublished data.

Table A–7

Herbicides Used by Farmers on Crops, 1964–76

Herbicide	1964	1966	1971	1976
Atrazine				
Pounds (1,000)	10,837	23,495	57,219	90,340
Acres treated (1,000)	7,912	14,978	39,842	61,750
Pounds/acre	1.4	1.6	1.4	1.5
Alachlor				
Pounds (1,000)	N.A.	N.A.	14,754	88,549
Acres treated (1,000)	N.A.	N.A.	11,636	53,533
Pounds/acre	N.A.	N.A.	1.3	1.7
2,4-D				
Pounds (1,000)	29,687	39,513	33,252	38,393
Acres treated (1,000)	56,300	56,893	54,845	58,618
Pounds/acre	0.5	0.7	0.6	0.7
Trifluralin				
Pounds (1,000)	N.A.	5,184	11,427	28,333
Acres treated (1,000)	N.A.	6,953	16,613	33,695
Pounds/acre	N.A.	0.7	0.7	0.8
Propachlor				
Pounds (1,000)	N.A.	2,269	23,730	11,015
Acres treated (1,000)	N.A.	1,632	14,848	5,362
Pounds/acre	N.A.	1.4	1.6	2.1
All Herbicides, total				
Pounds (1,000)	76,314	112,420	224,000	394,300
Acres treated (1,000)	N.A.	98,655	157,800	196,000
Pounds/acre	N.A.	1.1	1.4	2.0

N.A.—Not Available.

Sources: (1976) U.S. Department of Agriculture, Economics, Statistics, and Cooperatives Service, *Farmers' Use of Pesticides in 1976*, AER No. 418 (Washington, D.C.: U.S. Government Printing Office, 1978), pp. 9, 36, 38; (1971) U.S. Department of Agriculture, ERS, *Farmers' Use of Pesticides in 1971—Quantities*, AER No. 252 (Washington, D.C.: U.S. Government Printing Office, 1974), pp. 9, 40, 41; U.S. Department of Agriculture, ERS, *Farmers' Use of Pesticides in 1965*, AER No. 418 (Washington, D.C.: U.S. Government Printing Office, 1978), p. 9; (1966) U.S. Department of Agriculture, *Farmers' Use of Pesticides in 1966*, Tables 23 and 25, pp. 37, 38, 44; U.S. Department of Agriculture, ERS, *Farmers' Use of Pesticides in 1971—Extent of Crop Use*, AER No. 268 (Washington, D.C.: U.S. Government Printing Office, 1975), p. 9; (1964) U.S. Department of Agriculture, ERS, *Quantities of Pesticides Used by Farmers in 1964*, AER No. 131 (Washington, D.C.: U.S. Government Printing Office, 1968), pp. 19, 20.

Table A–8

Insecticides Used by Farmers in Crops, 1964–76

Insecticide	1964	1966	1971	1976
Toxaphene				
Pounds (1,000)	34,189	30,924	32,867	30,721
Acres treated (1,000)	8,028	5,383	5,601	4,851
Pounds/acre	4.3	5.8	5.9	6.3
Methyl Parathion				
Pounds (1,000)	9,981	7,991	27,562	22,787
Acres treated (1,000)	6,723	4,511	12,142	12,075
Pounds/acre	1.5	1.8	2.3	1.9
DDT [a]				
Pounds (1,000)	35,210	29,175	14,249	[c]
Acres treated (1,000)	12,226	8,896	3,170	
Pounds/acre	2.9	3.3	4.5	
Carbofuran				
Pounds (1,000)	N.A.	N.A.	2,854	11,613
Acres treated (1,000)	N.A.	N.A.	3,772	11,417
Pounds/acre	N.A.	N.A.	0.8	1.0
Ethyl Parathion				
Pounds (1,000)	6,138	8,437	9,372	6,559
Acres treated (1,000)	4,828	6,140	9,985	12,032
Pounds/acre	1.3	1.4	0.9	0.5
Aldrin/Dieldrin [b]				
Pounds (1,000)	12,046	15,455	8,228	865
Acres treated (1,000)	14,366	14,551	8,138	460
Pounds/acre	0.8	1.1	1.0	1.9
All Insecticides, total				
Pounds (1,000)	143,184	137,566	153,800	162,100
Acres treated (1,000)	N.A.	42,596	56,800	74,900
Pounds/acre	N.A.	3.2	2.7	2.2

N.A.—Not Available.

[a] DDT includes its related compound DDE.

[b] Aldrin/dieldrin use in 1976 includes aldrin only. The two are usually grouped together since aldrin rapidly breaks down into its metabolite, dieldrin. Therefore, most residues found in the environment are principally dieldrin.

[c] Use of DDT was prohibited in 1972, with a few minor exceptions.

Sources: (1976) U.S. Department of Agriculture, Economics, Statistics, and Cooperative Service, *Farmers' Use of Pesticides in 1976*, AER No. 418 (Washington, D.C.: U.S. Government Printing Office, 1978), pp. 15, 48, 52; (1971) U.S. Department of Agriculture, ERS, *Farmers' Use of Pesticides in 1961—Quantities*, AER No. 252 (Washington, D.C.: U.S. Government Printing Office, 1974), pp. 13, 50; U.S. Department of Agriculture, ERS, *Farmers' Use of Pesticides in 1976*, AER No. 418 (Washington, D.C.: U.S. Government Printing Office, 1978), p. 15; (1966) U.S. Department of Agriculture, ERS, *Farmers' Use of Pesticides in 1966*, Tables 28 and 30, pp. 50, 55; U.S. Department of Agriculture, ERS, *Farmers' Use of Pesticides in 1971—Extent of Crop Use*, AER No. 268 (Washington, D.C.: U.S. Government Printing Office, 1975), p. 9; (1964) U.S. Department of Agriculture, ERS, *Quantities of Pesticides Used by Farmers in 1964*, AER No. 131 (Washington, D.C.: U.S. Government Printing Office, 1968), pp, 26, 27.

Table A–9

Residues of Polychlorinated Biphenyls (PCBs) in Human Adipose Tissue, 1972–76

Fiscal Year	Sample Size	Total Detected (percent)	Not Detected (percent)	Percent Detected with PCBs [a] (parts per million)		
				<1 ppm	1–3 ppm	>3 ppm
1972	4,100	74.0		15.5	50.7	7.9
1973	1,120	78.6	21.4	41.6	31.2	5.8
1974	926	90.7	9.3	51.6	34.0	5.1
1975	779	94.4	5.6	56.1	27.6	10.6
1976	883	98.1	1.9	59.3	29.6	9.2

Data are based on the analysis of human adipose tissue collected from the general population via the National Human Adipose Tissue Surveys.

[a] Residue categories are presented on a whole tissue (wet weight) basis in parts per million (ppm).

Sources: (1972) Kutz, Yobs, and Strassman, U.S. Environmental Protection Agency, "Organochlorine Pesticide Residues in Human Adipose Tissue," *Bulletin of the Society of Pharmacological and Environmental Pathologists*, Volume IV, Number 1, March 1976, Table 7, p. 19; (1973–1976) U.S. Environmental Protection Agency, Office of Toxic Substances, unpublished data.

Table A–10

Toxic Residues in U.S. Fish, 1969–76

(in parts per million, geometric mean)

Year	DDT [a]	Toxaphene	Dieldrin [b]	PCBs
1969	1.06	N.A.	.08	1.06
1970	.87	N.A.	.08	1.07
1971	.67	<.05	.04	.90
1972	.59	.11	.07	1.07
1973	.40	.11	.04	.71
1974	.44	.11	.08	.96
1975	[c]	[c]	[c]	[c]
1976	.36	.35	.06	.87

Freshwater fish samples collected by Fish and Wildlife Service personnel in all 50 states as part of the National Pesticide Monitoring Program. Two-thirds of the fish sampled are bottom-dwelling species such as carp, suckers, or catfish. The remaining one-third of the fish sampled are predacious species, such as trout, walleye, bass, and bluegill. The whole fish is analyzed, not just the fillet.

[a] Includes DDT and its derivatives.
[b] Includes Aldrin.
[c] Not measured in 1975.

Source: U.S. Department of the Interior, Fish and Wildlife Service, Columbia National Fisheries Research Laboratory, Columbia, Missouri, unpublished data.

Table A–11

Toxic Residues in U.S. Waterfowl by Flyway, 1966–76

(in mean, parts per million wet weight)

Year	Pacific	Central	Mississippi	Atlantic
		DDE[a]		
1966	[b] 0.65	[a] 0.15	[a] 0.25	[a] 0.70
1969	0.71	0.30	0.40	1.03
1972	0.34	0.15	0.37	0.44
1976	0.22	0.28	0.25	0.32
		Dieldrin		
1966	<.01	<.01	<.01	<.01
1969	0.02	0.02	0.04	0.05
1972	0.01	0.02	0.02	0.02
1976	0.02	0.03	0.05	0.06
		PCBs		
1966	N.A.	N.A.	N.A.	N.A.
1969	0.20	0.20	0.44	1.29
1972	0.11	0.10	0.66	1.24
1976	0.16	0.15	0.23	0.52

N.A.—Not Available.

Residues are measured in wings of adult mallards sampled in the continental United States as part of the National Pesticide Monitoring Service by sportsmen. Residue level in wings reflect those found in the rest of the body. Over 5,000 duck wings are analyzed during each year's collection period.

[a] A derivative of DDT.

[b] Includes DDT and its metabolites.

Sources: (1966) Estimated from graph in Charles R., Walker, U.S. Fish and Wildlife Service, *Occurrence of PCB in the National Fish and Wildlife Monitoring Program*, p. 170; (1969) Donald H. White and Robert G. Heath, "Nationwide Residues of Organochlorines in Wings of Adult Mallards and Black Ducks, 1972–1973," *Pesticides Monitoring Journal*, Volume 9, No. 4, March 1976, p. 184; (1972–1976) Donald H., White, U.S. Fish and Wildlife Service, "Nationwide Residues of Organochlorines in Wings of Adult Mallards and Black Ducks, 1976," Table 3, *Pesticides Monitoring Journal*, in press.

Table A–12

Toxic Residues in U.S. Starlings, 1968–76

(in parts per million, geometric mean wet weight)

Year	DDE [a]	Dieldrin	PCBs
1968	.579	.084	[b]
1970	.355	.036	.358
1972	.387	.035	.215
1974	.229	.019	.068
1976	.254	.039	.243

Samples collected through trapping or shooting throughout the continental United States by Fish and Wildlife Service personnel as part of the National Pesticides Monitoring Program. Feet, beaks, wingtips and skins were removed and the remainder of the sample was analyzed. About 1,400 starlings are analyzed each year. Statistics are presented in terms of wet weight.

[a] DDE is a derivative of DDT.
[b] Not measured.

Sources: (1968) Donald H. White, "Nationwide Residues of Organochlorines in Starlings, 1974," *Pesticides Monitoring Journal*, Volume 10, No. 1, June 1976, Table 3, p. 15; (1970–1976) Donald H. White, U.S. Fish and Wildlife Service, "Nationwide Residues of Organochlorine Compounds in Starlings, 1976," *Pesticides Monitoring Journal*, Volume 12, No. 4, March 1979, Table 2, p. 197.

Table A–13

Radioactive Emissions From Nuclear Fallout as Measured by Strontium-90 and Cesium-137 in Pasteurized Milk, 1960–78

(in pico curies/liter) •

Year	Strontium-90	Cesium-137
1960	8.6	18
1961	8.0	11
1962	13.4	44
1963	23.5	108
1964	23.8	109
1965	17.6	58
1966	13.3	29
1967	10.2	16
1968	8.9	11
1969	7.5	9
1970	7.3	8
1971	6.8	9
1972	5.6	6
1973	4.4	5
1974	4.7	8
1975	3.9	9
1976	3.5	7
1977	3.6	6
1978	3.8	7

Data aggregated in network averages.

• A curie is a special unit of nuclear activity. One curie equals 3.7×10^{10} nuclear transformations per second. Pico is the prefix used to indicate multiplication by a factor of 10^{-12}, or one trillionth.

Source: U.S. Environmental Protection Agency, Eastern Environmental Radiation Facility, unpublished data.

Table A–14

Major Uses of Land, 1900–74

(in millions of acres)

Major Land Uses	1900	1910	1920	1930	1940	1950	1959	1969	1974
Cropland [a]	319	347	402	413	400	409	392	384	382
Grassland, pasture, and range [b]	832	778	731	719	719	701	699	692	681
Forest land [c]	719	721	721	722	727	721	728	723	718
Other [d]	400	424	416	416	426	442	452	465	483
Specialized [e]	—	—	86	—	99	134	146	172	182
Unused land [f]	—	—	330	—	327	308	306	293	301
Total U.S. [g] (50 states)	2270	2270	2270	2270	2272	2273	2271	2264	2264

[a] Cropland: Excludes cropland used only for pasture.

[b] Grassland, pasture, and range: Includes grassland pasture, other nonforested grazing land, and cropland used only for pasture. Includes some idle grassland, particularly before 1920.

[c] Forest land: Excludes reserved forest land in parks, wildlife refuges, and other special-use areas.

[d] Other: Includes specialized land and unused land.

[e] Specialized land: Includes urban and built-up areas (including cities and towns, rural highway and road rights-of-way, railroads, airports, and public institutions in rural areas) and nonurban special-use areas (including federal and state parks and other rural parks, recreational areas, federal and state wildlife refuges, national defense sites, flood-control areas, federal industrial areas, farmsteads, and farm roads). Years 1920 and 1940 are estimated based on a proportion of 48-state and 50-state data.

[f] Unused land: Includes miscellaneous uses such as marshes, open bare rock areas, deserts, tundra, and other uses not inventoried. Years 1920 and 1940 were estimated by subtracting Specialized from Other and are based on a proportion using 48-state and 50-state data.

[g] Changes in total land area are attributable to changes in methods and materials used in occasional remeasurements and to increases in the area of artificial reservoirs. The U.S. Department of Agriculture estimated data for 1900–59 assume essentially no change in Alaska and Hawaii prior to 1950. The estimates are not strictly comparable.

Sources: (1900, 1920, 1940–74 except specialized, 1920 and 1940) U.S. Department of Agriculture, Economics, Statistics and Cooperatives Service, *Major Uses of Land in the United States, Summary for 1974*, draft, June, 1978, Table 3, p. 3a; (Specialized, 1920 and 1940) U.S. Department of Agriculture, Economic Research Service, *Major Uses of Land and Water in the United States, Summary for 1959*, Agricultural Economic Report No. 13, pp. 10, 11; (1910, 1930) U.S. Department of Agriculture, Economics, Statistics, and Cooperatives Service, unpublished data.

Table A–15

National Wilderness Preservation System, 1964–79

(in millions of acres)

Year	Designated Wilderness		Proposed/Under Study		Total Designated and Proposed Wilderness
	Annual Addition	System Total	Annual Addition	System Total	
1964	9.244	9.244	37	37	46.24
1965	0	9.244	0	37	46.24
1966	0	9.244	0	37	46.24
1967	0	9.244	0	37	46.24
1968	0.788	10.032	0	37	47.03
1969	0.159	10.191	0	37	47.19
1970	0.204	10.395	0.21	37.21	47.60
1971	0	10.395	0.55	37.76	48.15
1972	0.631	11.026	0.20	37.96	48.99
1973	0	11.026	0	37.96	48.99
1974	0.354	11.380	0.62	38.58	49.96
1975	1.336	12.716	0.27	38.85	51.57
1976	1.738	14.454	0.65	[a]39.50	53.95
1977	0.031	14.485	15.4	[a,b]54.9	69.385
1978	4.516	19.001	2.4	[a,b]57.3	76.301
1979[c]	0	19.001	17.4	[a,b]74.7	93.701

[a] In addition, the 1976 BLM Organic Act includes approximately 120 million acres of BLM lands which are under consideration for Wilderness designation.

[b] Includes proposals before Congress and excludes areas Under Study.

[c] 1979 data as of February 1979.

Sources: (1964–1976) U.S. Department of Agriculture, Forest Service, Wilderness Monitoring System, computer printout, August 1, 1977; (1977–1979) U.S. Department of Agriculture, Forest Service, Recreation Management Staff, "Wilderness Fact Sheet," February 15, 1979; U.S. Department of Agriculture, Forest Service, unpublished data; U.S. Department of the Interior, National Park Service, unpublished data; U.S. Department of the Interior, Fish and Wildlife Service, unpublished data, and U.S. Department of the Interior, Bureau of Land Management, unpublished data.

Table A–16

National Wild and Scenic Rivers System, 1968–79

Year	Annual Addition		Cumulative Total	
	Number of Rivers	Miles	Number of Rivers	Miles
1968	8	788.65	8	788.65
1969	—	—	8	788.65
1970	1	95.0	9	883.65
1971	—	—	9	—
1972	1	27.0	10	910.65
1973	1	66.0	11	976.65
1974	1	56.9	12	1033.55
1975	3	123.9	15	1157.45
1976	5	464.7	[a] 19	1622.15
1977	—	—	[a] 19	1622.15
1978	8	659.2	[b] 25	2317.35
1979[c]	—	659.2	25	2317.35

[a] Excludes the Lower St. Croix, which was first admitted to the system in 1968.
[b] Excludes the Rio Grande and Missouri, which were first admitted to the system in 1968 and 1976, respectively.
[c] 1979 data as of July 1979.

Sources: CEQ, *Environmental Quality—1976*, p. 96 and U.S. Department of the Interior, National Park Service, unpublished data.

Table A–17

The National Park System, 1872–1978 [a]

Year	Natural		Classification Historical		Recreational		Decennial Totals		Cumulative Totals	
	Areas	Acreage (1,000)	Areas	Acreage (1,000)	Areas	Acreage (1,000)	Areas	Acreage (1,000)	Areas	Acreage (1,000)
1872–1880	1	2,219.8	4	1.0	0	—	5	2,220.8	5	2,220.8
1881–1890	3	1,608.0	3	10.4	1	1.8	7	1,620.2	12	3,841
1891–1900	1	235.4	4	9.4	0	—	5	244.8	17	4,085.8
1901–1910	16	3,692.3	12	79.3	0	—	28	3,771.6	45	7,857.4
1911–1920	10	5,519.7	9	39.6	0	—	19	5,559.3	64	13,416.8
1921–1930	16	4,394.3	25	65.4	1	7.0	42	4,466.7	106	17,883.4
1931–1940	13	6,149.6	27	187.6	7	1,679.6	47	8,016.8	153	25,900.2
1941–1950	0	—	18	77.8	1	100.1	19	177.9	172	26,078.1
1951–1960	1	14.5	14	12.8	3	1,253.2	18	1,280.5	190	27,358.6
1961–1970	8	1,098.2	36	14.5	23	1,277.1	67	2,389.8	257	29,748.4
1971–1978	19	41,886.2	29	209.2	17	3,565.2	65	45,660.6	322	75,409.0
Totals	88	66,818.0	181	707.0	53	7,884.0	322	75,409.0	322	75,409.0

Details may not add to totals due to rounding.

[a] Yearly totals calculated from earliest year of proclamation and/or authorization.

Sources: (1872–1975) U.S. Department of the Interior, National Park Service, *Index of the National Park System and Affiliated Areas as of January 1, 1975* (Washington, D.C.: U.S. Government Printing Office, 1975) and U.S. Department of the Interior, National Park Service, "Updated Addenda of October 22, 1976," for the *Index of the National Park System and Affiliated Areas as of January 1, 1975;* (1976–1978) U.S. Department of the Interior, National Park Service, *Index of the National Park System as of June 30, 1977* (Washington, D.C.: U.S. Government Printing Office, 1977) p. 9; U.S. Department of the Interior, National Park Service, "Areas Added to the National Park System, Since Publication of the *Index of the National Park System as of June 30, 1977*," prepared February 1979.

Table A–18

Visits to National and State Parks, 1954–78

(in millions of visitors)

Year	National	State
1954	•47.83	
1955	•50.01	
1956	•54.92	200.71
1957	•59.28	
1958	•58.68	237.33
1959	62.81	255.31
1960	79.23	259.00
1961	86.66	273.48
1962	97.04	284.80
1963	102.71	
1964	111.39	
1965	121.31	
1966	133.08	
1967	139.68	391.06
1968	150.84	
1969	163.99	
1970	172.00	482.54
1971	200.54	
1972	211.62	
1973	215.58	
1974	217.44	
1975	238.85	565.71
1976	267.76	
1977	262.60	
1978	283.09	

•Does not include visits to the National Capital Park System.

Sources: (State Parks) National Recreation and Park Association, *State Park Statistics 1970* (1971) p. 9, and National Recreation and Park Association, *State Park Statistics 1975*, p. 27© (National Parks, 1954–1975) U.S. Department of the Interior, National Park Service, *Public Use of the National Parks: A Statistical Report, 1954–64* (Washington, D.C.: U.S. Government Printing Office, 1966), p. 4; U.S. Department of the Interior, National Park Service, *Public Use of the National Parks: A Statistical Report, 1960–1970* (Washington, D.C.: U.S. Government Printing Office, 1971), p. 5; U.S. Department of the Interior, National Park Service, *Public Use of the National Parks, December, 1972* (Washington, D.C.: U.S. Government Printing Office, 1972), p. 9; Department of the Interior, National Park Service, *Public Use of the National Park System, Calendar Year Report 1973* (Washington, D.C.: U.S. Government Printing Office, 1974), p. 6; and Department of the Interior, National Park Service, *Public Use of the National Park System, Calendar Year Report 1975* (Washington, D.C.: U.S. Government Printing Office, 1976), p. 23; (1976) U.S. Department of the Interior, National Park Service, *National Park Statistical Abstract, 1977* (Washington, D.C.: U.S. Government Printing Office, 1978), Table 2, p. 2; (1977–1978) U.S. Department of the Interior, National Park Service, *National Park Statistical Abstract 1978* (Washington, D.C.: U.S. Government Printing Office, 1979), Table 2, p. 2.

Table A–19

U.S. Cropland, 1949–78

(in millions of acres)

Cropland use	1949	1954	1959	1964	1969	1974	1975	1976	1977	1978[a]
Total cropland used for crops[b]	387	380	358	335	333	361	366	370	377	368
Harvested	352	339	317	292	286	322	330	331	337	330
Crop failure	9	13	10	6	6	8	6	9	10	7
Cultivated summer fallow	26	28	31	37	41	31	30	30	30	31
Total cropland excluding pasture	409	399	391	387	384	382	N.A.	N.A.	N.A.	N.A.
Soil improvement and idle cropland	22	19	33	52	51	21	N.A.	N.A.	N.A.	N.A.
Total cropland including pasture	478	465	457	444	472	465	N.A.	N.A.	N.A.	N.A.
Cropland pasture	69	66	66	57	88	83	N.A.	N.A.	N.A.	N.A.
Diverted acres[c]	N.A.	N.A.	22	55	57	N.A.	N.A.	N.A.	N.A.	N.A.

N.A.—Not Available.

[a] Preliminary data.
[b] Includes principal and minor crops.
[c] Acreage diverted or set aside to comply with Federal Farm Supply Management Programs. This acreage is mostly included in the soil improvement and idle cropland category but some is included in the cultivated summer fallow category of cropland.

Source: U.S. Department of Agriculture Economic Research Service, *Our Land and Water Resources,* Miscellaneous Publication No. 1290 (Washington, D.C.: U.S. Government Printing Office, 1974), p. 4; U.S. Department of Agriculture, Economics, Statistics, and Cooperatives Service, *Major Uses of Land in the United States, Summary for 1974,* draft, June 1978, pp. 8 and 12a; and U.S. Department of Agriculture, Economics, Statistics, and Cooperatives Service, unpublished data.

Table A–20

Agricultural Inputs, 1950–73

Year	Crop	Live-stock	Cropland Used for Crops (million acres)	Average Size of Farms [a] (acres)	Hours used for Farmwork [b] (millions)	Horsepower of Farm Machines [c] (millions)	Fertilizer [d] (thousands of tons)	Synthetic Organic Pesticides [e] (million pounds)	Irrigated land (million acres)			Farm Energy Use [g] (trillion Btu)
									Total U.S.	17 West-ern States [f]	All other States	
1950	N.A.		377	213	15,137	93	4,058	286	25.8	24.3	1.5	1,203.9
1951	N.A.		381	222	15,222	101	4,728	464	N.A.	N.A.	N.A.	—
1952	N.A.		380	232	14,504	108	5,205	—	N.A.	N.A.	N.A.	—
1953	N.A.		380	242	13,966	115	5,646	—	N.A.	N.A.	N.A.	—
1954	N.A.		380	251	13,310	121	5,896	—	29.6	27.0	2.6	1,303.9
1955	N.A.		378	258	12,808	126	6,109	506	N.A.	N.A.	N.A.	—
1956	N.A.		369	265	12,028	134	6,055	—	N.A.	N.A.	N.A.	1,413.8
1957	N.A.		358	273	11,059	139	6,377	—	N.A.	N.A.	N.A.	—
1958	N.A.		355	280	10,548	144	6,512	—	N.A.	N.A.	N.A.	—
1959	N.A.		358	288	10,301	150	7,414	—	33.2	30.7	2.4	—
1960	93	88	355	297	9,795	153	7,463	648	N.A.	N.A.	N.A.	1,484.0
1961	92	91	340	305	9,400	158	7,844	700	N.A.	N.A.	N.A.	—
1962	92	92	331	314	8,979	162	8,448	730	N.A.	N.A.	N.A.	—
1963	96	95	337	322	8,664	167	9,505	763	N.A.	N.A.	N.A.	—
1964	93	97	335	332	8,194	172	10,460	783	37.1	33.2	3.9	1,747.9
1965	99	95	336	340	7,335	176	10,987	877	N.A.	N.A.	N.A.	—
1966	95	97	332	348	6,858	182	12,445	1,013	N.A.	N.A.	N.A.	—
1967	100	100	340	355	6,677	189	13,974	1,050	N.A.	N.A.	N.A.	—
1968	103	100	335	363	6,416	195	15,035	1,192	N.A.	N.A.	N.A.	1,995.9
1969	104	101	333	369	6,198	199	15,515	1,104	39.1	34.8	4.3	—
1970	100	105	332	374	5,986	203	16,068	1,034	N.A.	N.A.	N.A.	—
1971	112	106	340	378	5,741	206	17,168	1,136	N.A.	N.A.	N.A.	2,087.6
1972	113	107	334	382	5,433	209	17,212	1,158	N.A.	N.A.	N.A.	—
1973	119	105	352	385	5,321	212	18,029	1,289	N.A.	N.A.	N.A.	—

1974	110	106	361	388	5,178	219	19,338	1,417	41.2	36.6	4.6	—
1975	121	101	366	391	4,990	222	17,572	1,603	N.A.	N.A.	N.A.	—
1976	121	105	370	394	4,807	228	20,849	1,364	N.A.	N.A.	N.A.	—
1977	129	106	377	397	[b] 4,659	232	[b] 22,097	1,388	N.A.	N.A.	N.A.	—
1978	[b] 128	[b] 108	368	[b] 400	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	—

N.A.—Not Available.

[a] Excludes Alaska and Hawaii prior to 1959.
[b] Includes crops, livestock, overhead. After 1964, time used for horses, mules, and farm gardens was excluded.
[c] Includes tractors only (exclusive of steam and garden).
[d] Includes nitrogen, phosphate, and potash nutrients used.
[e] Includes production data only.
[f] Western states include Texas, Oklahoma, Kansas, Nebraska, South Dakota, North Dakota, Montana, Wyoming, Colorado, New Mexico, Arizona, Utah, Idaho, Washington, Oregon, Nevada, and California.
[g] Btus converted from kilocalories (kcal), as published in J. S. Steinhart and C. E. Steinhart, "Energy Use in the Food System," *Science*, Vol. 184, April 19, 1974. (1 kcal+ 3.968 Btus; 1 Btu=.252 kcal) Includes fuel, electricity, agricultural steel, farm machinery, tractors, and irrigation.
[h] Preliminary data.

Source: (Cropland and Livestock Production) 1960–1962: U.S. Department of Agriculture, *Agricultural Statistics 1975* (Washington D.C.: U.S. Government Printing Office, 1975), Table 618, p. 440; 1963–1974: U.S. Deparment of Agriculture, *Agricultural Statistics 1978* (Washington, D.C.: U.S. Government Printing Office, 1978), Table 636, p. 441; 1975–1978: U.S. Department of Agriculture, *1978 Handbook of Agricultural Charts*, Agricultural Handbook No. 551 (Washington, D.C.: U.S. Government Printing Office, 1978), p. 16; (Cropland) U.S. Department of Agriculture, Economics, Statistics, and Cooperatives Service, *Changes in Farm Production and Efficiency, 1977*, Statistical Bulletin No. 612, (Washington, D.C.: U.S. Government Printing Office, 1978) p. 19, and U.S. Department of Agriculture, Economics, Statistics, and Cooperatives Service, unpublished data; (Average Size of Farms) 1950–1978: U.S. Bureau of the Census, *Statistical Abstract, 1978* (Washington, D.C.: U.S. Government Printing Office, 1978), Table 116, p. 686; (Hours used for Farmwork) U.S. Department of Agriculture, Economics, Statistics, and Cooperatives Service, *Changes in Farm Production and Efficiency, 1977*, Statistical Bulletin No. 612, (Washington, D.C.: U.S. Government Printing Office, 1978), p. 32; (Horsepower of Farm Machines) U.S. Department of Agriculture, Economics, Statistics, and Cooperatives Service, *Changes in Farm Production and Efficiency, 1977*, Statistical Bulletin No. 612, (Washington, D.C.: U.S. Government Printing Office, 1978), p. 31; (Fertilizer) U.S. Department of Agriculture, Economics, Statistics and Cooperatives Service, *Changes in Farm Production and Efficiency, 1977*, Statistical Bulletin No. 612, (Washington, D.C.: U.S. Government Printing Office, 1978), p. 27; (Synthetic Organic Pesticides) International Trade Commission, *Synthetic Organic Chemicals*, annual issues; (Irrigated Land) U.S. Bureau of the Census, *Historical Statistics, Colonial Times to 1970*, (Washington, D.C.: U.S. Government Printing Office, 1975), p. 433, and U.S. Bureau of the Census, *1974 Census of Agriculture*, Volume II, Part 9, (Washington, D.C.: U.S. Government Printing Office, 1978), pp. 1–10; (Farm Energy Use) U.S. Department of Agriculture, Economic Research Service, *The U.S. Food and Fiber Sector: Energy Use and Outlook*, committee print prepared for the Subcommittee on Agricultural Credit and Rural Electrification of the Committee on Agriculture and Forestry, U.S. Senate, 93rd Congress, second session, September 20, 1974, p. 2.

Table A–21

Cropland Soil Erosion [a] due to Water and Wind, by State, 1977

State	Nonfederal Cropland (1,000 acres)	Water (sheet and rill) (1,000 ton/yr)	Erosion[b] (tons/acre/year)	Wind (1,000 tons/acre/year)	Erosion[c] (tons/acre/year)
Alabama	4,499	39,904	9.90	N.A.	N.A.
Arizona	1,312	593	0.45	N.A.	N.A.
Arkansas	7,990	51,809	6.48	N.A.	N.A.
California	10,073	7,626	0.76	N.A.	N.A.
Colorado	11,093	27,687	2.50	99,179	8.94
Connecticut	201	855	4.13	N.A.	N.A.
Delaware	542	1,854	3.49	N.A.	N.A.
Florida	3,189	13,298	4.17	N.A.	N.A.
Georgia	6,487	42,645	6.58	N.A.	N.A.
Hawaii	293	3,975	13.71	N.A.	N.A.
Idaho	6,287	14,843	2.36	N.A.	N.A.
Illinois	23,836	160,056	6.72	N.A.	N.A.
Indiana	13,320	68,607	5.15	N.A.	N.A.
Iowa	26,431	261,719	9.91	N.A.	N.A.
Kansas	28,806	108,797	3.78	84,760	2.94
Kentucky	5,428	51,163	9.40	N.A.	N.A.
Louisiana	5,899	46,637	7.90	N.A.	N.A.
Maine	907	2,724	2.99	N.A.	N.A.
Maryland	1,677	10,238	6.08	N.A.	N.A.
Massachusetts	282	598	2.11	N.A.	N.A.
Michigan	9,484	21,604	2.28	N.A.	N.A.
Minnesota	22,916	52,906	2.31	N.A.	N.A.
Mississippi	7,302	79,623	10.92	N.A.	N.A.
Missouri	14,573	165,701	11.38	N.A.	N.A.
Montana	15,355	16,523	1.08	58,450	3.81
Nebraska	20,699	118,623	5.74	25,903	1.25
Nevada	1,107	43	0.04	N.A.	N.A.
New Hampshire	273	308	1.14	N.A.	N.A.
New Jersey	777	5,105	6.54	N.A.	N.A.
New Mexico	2,282	4,552	2.00	26,139	11.49
New York	5,969	28,895	4.85	N.A.	N.A.
North Carolina	6,190	47,204	7.64	N.A.	N.A.
North Dakota	26,918	54,215	2.01	47,317	1.76
Ohio	11,762	42,199	3.59	N.A.	N.A.
Oklahoma	11,783	43,435	3.68	35,091	2.97
Oregon	5,148	5,617	1.09	N.A.	N.A.
Pennsylvania	5,661	31,015	5.49	N.A.	N.A.
Rhode Island	30	77	2.96	N.A.	N.A.
South Carolina	3,331	15,948	4.77	N.A.	N.A.
South Dakota	18,156	44,416	2.45	53,730	2.96
Tennessee	4,928	69,461	14.12	N.A.	N.A.
Texas	30,439	105,525	3.47	453,906	14.92
Utah	1,815	991	0.55	N.A.	N.A.
Virginia	3,209	21,211	6.61	N.A.	N.A.
Washington	7,951	12,116	1.52	N.A.	N.A.
West Virginia	991	3,632	3.65	N.A.	N.A.
Wisconsin	11,741	42,236	3.60	N.A.	N.A.
Wyoming	2,970	4,651	1.57	7,152	2.41
Caribbean	363	14,753	40.64	N.A.	N.A.
Total	413,267	1,969,444	4.77	891,627	5.29

Soil Conservation Service estimates include nonfederal cropland only and exclude Alaska.

N.A.—Not Available. Estimates of soil loss due to wind erosion are not available for other than the 10 Great Plains states.

Table A–21 (continued)

[a] Erosion is a normal process and occurs where water, wind, or other erosive elements remove soil or rock from sloping land areas. Erosion can be accelerated by man's actions, such as clearing away vegetation to grow crops.

[b] Water erosion is of two types: Sheet and rill. Sheet erosion occurs as beating rain and flowing water remove layers of soil from fields. Rill erosion occurs as this flowing water carves out channels.

[c] Wind erosion is caused by a strong turbulent wind blowing across an unprotected soil surface that is smooth, bare, loose, dry, and finely granulated. Wind erosion usually begins on exposed knolls, in tracks or paths made by implements or animals, and in turn rows where the vegetation and surface soil have been pulverized.

Source: U.S. Department of Agriculture, Soil Conservation Service, *1977 National Erosion and Inventory Estimates*, unpublished computer printouts, December 1978, Tables J1 and K1 and April 1979, Table 2.

Table A–22

Commercial Forest Land, by Ecosystem,[a] 1970 and 1977

Ecosystem	1970		1977[b]	
	Total Area (thousand acres)	Percent of Total Forest	Total Area (thousand acres)	Percent of Total Forest
Eastern[c]				
Softwood types[d]:				
Loblolly-Shortleaf Pine	52,832	10.7	49,911	10.2
Longleaf-Slash Pine	18,315	3.7	17,016	3.4
Spruce-Fir	18,913	3.8	18,286	3.7
White-Red-Jack Pine	12,168	2.5	12,294	2.5
Total	102,228	20.7	97,507	20.0
Hardwood types[c]:				
Oak-Hickory	111,861	22.6	110,809	22.7
Oak-Pine	35,028	7.1	34,550	7.1
Oak-Gum-Cypress	30,630	6.2	26,914	5.5
Maple-Beech-Birch	31,140	6.3	32,940	6.8
Elm-Ash-Cottonwood	24,728	5.0	25,249	5.2
Aspen-Birch	20,484	4.1	19,634	4.0
Total	253,871	51.3	250,096	51.3
Nonstocked	14,343	2.9	11,599	2.4
Total Eastern	370,442	74.9	359,203	73.6
Western[c]				
Softwood types[d]:				
Douglas Fir	30,788	6.2	30,629	6.3
Ponderosa Pine	27,964	5.6	26,649	5.5
Fir-Spruce	17,830	3.6	19,844	4.1
Lodgepole Pine	13,235	2.7	12,735	2.6
Hemlock-Sitka Spruce	10,819	2.2	13,226	2.7
Larch	2,743	.5	2,424	.5
White Pine	829	.2	446	.1
Redwood	803	.2	662	.1
Total	105,011	21.2	106,615	21.9
Hardwood types[c]:	12,818	2.6	14,994	3.1
Nonstocked	6,379	1.3	6,408	1.3
Total Western	124,208	25.1	[f]128,523	26.3
Total, all groups	[e]494,650	100.0	487,726	100.0

[a] Forest ecosystems describe associations of tree species, which in turn reflect factors of site, climate and stand history. The forest groups presented are combinations of more than 80 local forest types traditionally used for forest management purposes. Classifications are based upon the tree species presently forming a plurality of stocking. Data are for total commercial forest, all ownerships.

[b] Preliminary data.

[c] Eastern includes the Forest Service's North and South regions. States included are North Dakota, part of South Dakota, Nebraska, Oklahoma, Texas, and all states east of those states. Western includes the Forest Service's Rocky Mountain and Pacific Coast regions. States included are Montana, Wyoming, part of South Dakota, Colorado, New Mexico, and all states west of these states, including Alaska and Hawaii.

[d] Softwoods: Coniferous trees, usually evergreen, having needles or scale-like leaves.

Table A–22 (continued)

[d] Hardwoods: Dicotyledonous trees, usually broad-leaved and deciduous.
[f] Includes other eastern softwoods not previously classified.
[g] Not included are 5 million acres of "unregulated" commercial timberlands on National Forests in the Rocky Mountain states.

Sources: (1970) U.S. Department of Agriculture, Forest Service, *The Outlook for Timber in the United States*, Forest Resource Report No. 20, (Washington, D.C.: U.S. Government Printing Office, 1974), p. 12; (1977) U.S. Department of Agriculture, Forest Service, *Forest Statistics of the U.S., 1977*, (Washington, D.C.: U.S. Government Printing Office, 1978), Tables 4 and 5, pp. 12 and 17.

Table A–23

Forest Area Burned, 1950–77

Year	Total [a]		Protected Area				Unprotected Area	
			Federal Lands [b]		State and Private Lands [a]		State and Private Lands [c]	
	Number of Fires	Area Burned (1,000 acres)	Number of Fires	Area Burned (1,000 acres)	Number of Fires	Area Burned (1,000 acres)	Number of Fires	Area Burned (1,000 acres)
1950	208,402	15,519	8,418	391	96,578	3,408	103,404	11,720
1951	164,090	10,781	8,638	471	97,230	3,055	58,222	7,255
1952	188,277	14,187	9,634	281	118,363	6,347	60,280	7,559
1953	154,160	9,976	10,149	318	94,446	2,534	49,565	7,124
1954	176,891	8,833	8,592	176	118,681	2,787	49,614	5,830
1955	145,180	8,069	6,830	364	80,774	2,448	57,576	4,976
1956	143,485	6,606	11,341	372	82,997	1,613	49,147	4,621
1957	83,392	3,410	6,219	188	59,483	1,099	17,690	2,123
1958	97,910	3,280	12,942	288	67,366	1,173	17,602	1,819
1959	104,662	4,156	8,935	897	77,802	1,681	17,925	1,578
1960	103,387	4,478	12,090	622	77,537	1,909	13,760	1,947
1961	98,517	3,036	14,122	303	72,247	1,125	12,148	1,608
1962	115,345	4,079	10,421	270	94,487	1,646	10,437	2,163
1963	164,183	7,121	11,493	209	134,427	3,108	18,263	3,804
1964	116,358	4,197	8,877	194	90,480	1,670	17,001	2,333
1965	113,684	2,652	9,073	146	91,495	1,206	13,116	1,300
1966	122,500	4,574	11,571	1,265	98,157	1,908	12,772	1,401
1967	125,025	4,659	11,495	342	102,267	1,926	11,263	2,390
1968	125,371	4,232	10,027	1,205	107,689	1,633	7,655	1,394
1969	113,351	6,689	10,112	4,112	97,393	1,582	5,846	995
1970	121,736	3,279	14,968	719	101,455	1,541	5,313	1,019
1971	108,398	4,278	13,167	1,719	91,673	1,826	3,558	733
1972	124,554	2,641	15,937	1,232	83,010	1,050	25,607	359

1973	117,955	1,915	12,806	676	78,877	1,086	26,272	153
1974	145,868	2,879	15,040	1,200	105,835	1,511	24,993	168
1975	134,872	1,791	12,272	408	91,026	1,119	31,574	264
1976	241,699	5,110	15,800	519	157,035	2,119	68,864	2,472
1977	174,000	N.A.	N.A.	802	N.A.	2,096	N.A.	N.A.

N.A.—Not Available.

[a] Includes Alaska and Hawaii beginning 1960.

[b] Includes Hawaii beginning 1952. Includes Alaska beginning 1960. Federal lands are National Forests, public domains, and lands administered by the U.S. Department of the Interior, Soil Conservation Service, Tennessee Valley Authority, etc.

[c] Includes Hawaii. Includes Alaska beginning 1960.

Source: (1950–1976) U.S. Bureau of the Census, *Historical Statistics, Colonial Times to 1970*, Series L48–L55 (Washington, D.C.: United States Government Printing Office, 1975), p. 536, and U.S. Department of Agriculture, Forest Service, *Wildlife Statistics*, annual issues; (1977) U.S. Bureau of the Census, *Statistical Abstract, 1978* (Washington, D.C.: U.S. Government Printing Office, 1978), Table 1264, p. 733.

Table A–24

Sawtimber Growth and Harvest,[a] by Type and Ownership, 1952–76

(in billions of board feet) [b]

Type	Total All Ownerships				National Forest				Other Public [c]				Forest Industry				Farm and Miscellaneous Private			
	1952	1962	1970	1976	1952	1962	1970	1976	1952	1962	1970	1976	1952	1962	1970	1976	1952	1962	1970	1976
Total growth, softwood and hardwood	45.0	54.2	65.0	73.6	7.7	9.2	11.3	12.7	4.0	5.0	5.8	6.8	9.5	11.3	13.6	14.5	23.8	28.6	34.3	39.6
Total harvest,[d] softwood and hardwood	52.2	51.4	62.5	66.2	6.7	11.0	13.4	12.5	2.7	3.6	4.9	5.8	17.2	14.5	18.5	21.3	25.5	22.2	25.7	26.5
Softwood:																				
Growth	29.4	36.0	43.2	49.1	6.8	8.0	9.9	11.0	11.3	3.0	3.6	4.0	7.8	9.2	10.8	11.3	11.8	15.3	18.4	22.1
Harvest [d]	39.1	38.7	47.1	51.7	6.4	10.7	12.9	12.0	2.3	3.2	4.3	5.0	15.6	12.7	16.4	19.3	14.9	12.0	13.6	15.3
Hardwood:																				
Growth	15.6	18.1	21.8	24.3	0.9	1.2	1.3	1.7	1.0	1.5	1.7	2.1	1.7	2.1	2.9	3.2	12.0	13.3	16.0	17.4
Harvest [d]	13.0	12.7	15.4	14.5	0.4	0.4	0.6	0.6	0.4	0.4	0.6	0.7	1.6	1.8	2.0	2.0	10.7	10.2	12.1	11.2

All data are preliminary. Details may not add to totals due to rounding.

[a] Sawtimber is defined as live trees of commercial species containing at least one 12-foot saw log or two noncontiguous 8-foot logs. Softwood must be a minimum of 9 inches in diameter except in the West, where the minimum is 11 inches. Hardwood must be 11 inches in diameter in all states.

[b] Measured using the international one-quarter inch log rule.

[c] Includes Bureau of Land Management, Bureau of Indian Affairs, other federal, state, county, and municipal lands.

[d] Volume of growing stock trees removed from the inventory by harvesting, cultural operations (such as timberstand improvement), land clearing, or changes in land use.

Source: U.S. Department of Agriculture, Forest Service, *Forest Statistics of the U.S., 1977* (Washington, D.C.: U.S. Government Printing Office, 1978), Tables 34 and 35, pp. 84, 86.

Table A–25

Recreational Use of the National Forests, 1965–77

(in thousands of visitor-days)[a]

Year[b]	Campgrounds	Winter Sports Sites	Other Special Use[c]	Other Developed Sites	Wilderness System	Other Dispersed	Total
1965	34,040.0	5,481.6	19,914.0	9,443.0	4,522.1	84,350.9	160,336.1
1966	32,664.1	4,842.6	18,186.1	8,182.2	4,790.7	82,063.2	150,728.9
1967	30,230.7	5,102.3	17,662.3	7,879.5	4,690.1	84,082.2	149,647.1
1968	30,665.1	5,564.0	18,500.3	7,742.5	5,056.2	89,137.2	156,665.3
1969	31,669.6	5,661.8	18,186.7	8,222.2	5,071.9	94,025.9	162,838.1
1970	34,562.3	6,478.8	17,716.9	8,897.2	5,842.8	99,056.5	172,554.5
1971	35,731.7	6,961.7	17,572.5	9,396.3	8,103.6	100,343.7	178,109.5
1972	36,079.5	6,520.6	17,442.8	9,590.2	6,459.4	107,865.8	183,958.3
1973	35,965.2	8,290.0	16,681.0	9,764.1	6,681.7	110,792.6	188,174.6
1974	35,677.9	7,722.0	17,103.4	9,455.0	6,743.2	116,214.3	192,915.8
1975	37,721.2	8,921.3	17,640.9	10,781.5	7,802.0	116,333.9	199,200.8
1976	37,134.9	7,143.7	17,395.4	11,458.9	7,105.6	119,689.6	199,928.1
1977	37,545.9	6,970.3	16,946.4	12,305.0	8,008.3	123,023.6	204,797.4

[a] A visitor-day equals recreational use of National Forest land and water that aggregates to 12 person-hours. It may entail 1 person for 12 hours, 12 persons for 1 hour, or any equivalent combination of individual or group use, either continuous or intermittent.

[b] Calendar year.

[c] Private concessioners with permits.

Source: U.S. Department of Agriculture, Forest Service, Recreation Information Management System, unpublished data.

Table A–26

U.S. Rangeland, by Productivity and Ecosystem, 1976

(in thousands of acres)

Ecosystem	Area	Ecosystem Average (pounds per acre)	Herbage and Browse Production Productivity Class			
			1[a]	2[b]	3[c]	4[d]
Grassland:						
Mountain grasslands	26,871	1,661	0	914	20,826	5,131
Mountain meadows	3,285	2,824	0	2,090	1,195	0
Plains grasslands	175,233	1,016	0	1,826	80,592	92,815
Prairie	41,185	3,318	1,985	9,691	29,509	0
Desert grasslands	24,744	307	0	0	0	24,744
Annual grasslands	10,153	2,064	0	1,987	5,992	174
Wet grasslands	4,408	5,139	1,317	2,459	0	632
Alpine	6,775	564	0	0	783	5,992
Shrublands:						
Sagebrush	129,961	1,027	0	0	61,889	68,072
Desert shrub	81,171	249	0	0	2,908	78,263
Southwestern shrubsteppe	43,218	488	0	0	790	42,614
Shinnery	4,726	1,870	8	1,689	385	2,644
Texas savanna	28,429	2,142	0	5,502	21,610	1,317
Chaparral-mountain shrub[e]	14,120	1,929	0	4,207	6,617	3,296
Pinyon-juniper[e]	47,304	385	0	0	0	47,304
Desert	7,490	0	0	0	0	0

Data are for 48 states only. All data are preliminary.

[a] 1—5,000 pounds or more per acre per year.
[b] 2—3,000 to 4,999 pounds.
[c] 3—1,000 to 2,999 pounds.
[d] 4—less than 1,000 pounds.
[e] These two ecosystems can also be considered as forest land.

Source: U.S. Department of Agriculture, Forest Service, *An Assessment of the Forest and Rangeland Situation in the United States,* preliminary draft 1979, p. 35.

Table A–27

U.S. Rangeland, by Quality Condition and Ecosystem, 1976

(thousand acres)

Ecosystem	Total Area	Condition			
		High[a]	Moderately High[b]	Moderately Low[c]	Low[d]
Contiguous States:					
Grasslands					
Mountain grasslands	26,871	4,705	9,725	8,392	4,049
Mountain meadows	3,285	1,063	1,276	692	254
Plains grasslands	175,233	25,808	59,878	69,373	20,177
Prairie	41,185	5,740	14,097	15,695	5,653
Desert grasslands	24,744	2,086	6,109	12,483	4,066
Wet grasslands	4,408	748	1,218	911	1,531
Annual grasslands	10,153	1,336	510	3,731	4,576
Alpine	6,775	2,897	1,835	1,948	95
Total, grasslands	292,654	44,382	94,645	113,225	40,401
Shrublands					
Sagebrush	129,961	16,023	46,826	45,602	21,510
Desert shrub	81,171	14,130	29,581	25,547	11,913
Shinnery	4,726	780	1,307	1,915	724
Texas savanna	28,429	4,666	6,689	13,037	4,037
Southwestern shrub-steppe	43,218	4,535	6,398	17,925	14,359
Chaparral-mountain shrub*	14,120	1,654	3,083	5,442	3,941
Pinyon-juniper*	47,304	4,285	13,509	21,012	8,498
Desert	7,490	5,739	865	486	400
Total, Shrublands	356,419	51,812	108,258	130,967	65,382
Total, 48 states	649,073	96,194	202,904	244,192	105,783
Alaska:					
Muskeg-bog	14,383	14,383	0	0	0
Shrub thickets	17,762	14,853	2,023	886	0
Moist tundra	66,576	40,344	22,902	3,330	0
Wet tundra	26,256	26,256	0	0	0
Alpine tundra	103,114	85,069	18,045	0	0
Aleutian moist tundra	1,215	850	365	0	0
Aleutian alpine	2,165	1,517	541	107	0
Total, Alaska	231,471	183,272	43,876	4,323	0
Hawaii:					
Forest-shrub-grass mosaic	493	72	72	95	254
Koa-mamani-parkland	250	117	58	73	2
Grass-shrub-barren mosaic	225	154	36	30	5
Total, Hawaii	968	343	166	198	261
Total, United States	881,512	279,809	246,945	248,713	106,044

All data are preliminary.

Definitions for the 4 condition classes used here are:
[a] High: vegetation and soils deviate from site potential by less than 40 percent.
[b] Moderately high: vegetation and soils deviate 40 to 59 percent from potential.
[c] Moderately low: vegetation and soils deviate 60 to 79 percent from potential.
[d] Low: vegetation and soils deviate by 80 percent or more from potential.
* These two ecosystems can also be considered as forest land.

Source: U.S. Department of Agriculture, Forest Service, *An Assessment of the Forest and Rangeland Situation in the United States*, draft 1979, p. 242.

Table A–28

Big Game Populations on U.S. Forest Service Lands, 1960–77

Year	Mule Deer	Whitetail Deer	Blacktail Deer	Elk	Turkey	Black Bear	Antelope	Mountain Goat	Moose	Javelina
1960	2,160,000	902,000	559,000	299,000	99,000	109,000	54,000	26,000	16,000	N.A.
1961	2,322,000	898,000	620,000	313,000	120,000	109,000	54,000	30,000	17,000	N.A.
1962	2,413,000	935,000	670,000	334,000	116,000	109,000	49,000	29,000	20,000	N.A.
1963	2,380,000	865,000	688,000	338,000	131,000	106,000	51,000	31,000	21,000	N.A.
1964	2,351,000	900,000	714,000	346,000	152,000	105,000	48,000	31,000	21,000	N.A.
1965	2,367,000	936,000	720,000	361,000	164,000	108,000	50,000	32,000	21,000	N.A.
1966	2,204,000	879,000	720,000	357,000	160,000	110,000	46,000	31,000	21,000	N.A.
1967	2,251,000	928,000	817,000	375,000	162,000	108,000	44,000	30,000	21,000	N.A.
1968	2,144,000	930,000	765,000	351,000	155,000	103,000	38,000	31,000	22,000	N.A.
1969	2,138,000	887,000	666,000	361,000	155,000	100,000	38,000	31,000	21,000	N.A.
1970	2,089,000	861,000	659,000	362,000	159,000	98,000	37,000	31,000	24,000	N.A.
1971	2,013,000	809,000	645,000	366,000	165,000	97,000	39,000	30,000	23,000	N.A.
1972	1,852,000	810,000	630,000	368,000	175,000	97,000	42,000	29,000	25,000	N.A.
1973	1,767,000	782,000	516,000	365,000	171,000	92,000	39,000	29,000	25,000	20,000
1974	1,662,000	824,000	506,000	387,000	175,000	93,000	42,000	27,000	25,000	21,000
1975	1,491,000	814,000	504,000	396,000	165,000	94,000	46,000	27,000	22,000	21,000
1976	1,396,000	783,000	519,000	401,000	169,000	96,000	45,000	24,000	23,000	20,000
1977	1,405,000	807,000	511,000	431,000	176,000	93,000	50,000	24,000	23,000	21,000

Year	Bighorn Sheep	Mountain Lion	Alligator	Alaska Brown Bear	Wild Boar	Dall Sheep	Wolf	Grizzly Bear	Caribou	Barbary Sheep	Bison
1960	11,000	N.A.	N.A.	6,230	1,365	1,000	N.A.	745	N.A.	N.A.	N.A.
1961	11,100	N.A.	N.A.	6,235	2,505	900	N.A.	775	N.A.	N.A.	N.A.
1962	11,100	N.A.	N.A.	6,235	2,020	900	N.A.	805	N.A.	N.A.	N.A.
1963	11,100	N.A.	N.A.	6,335	2,010	900	N.A.	820	N.A.	N.A.	N.A.
1964	12,100	N.A.	N.A.	6,335	2,130	900	N.A.	780	N.A.	N.A.	N.A.
1965	13,000	N.A.	N.A.	6,200	2,300	900	N.A.	900	N.A.	N.A.	N.A.
1966	13,000	N.A.	N.A.	6,300	2,400	900	2,500	900	150	N.A.	N.A.
1967	14,000	N.A.	N.A.	6,330	2,600	900	2,800	903	150	N.A.	N.A.
1968	13,000	N.A.	N.A.	6,419	2,700	900	2,700	829	175	N.A.	N.A.
1969	12,800	N.A.	N.A.	6,350	2,500	1,210	2,500	832	160	N.A.	N.A.
1970	12,800	N.A.	N.A.	8,350	1,900	1,205	2,700	830	125	N.A.	N.A.
1971	12,850	N.A.	N.A.	5,960	2,600	1,150	2,600	700	260	N.A.	N.A.
1972	12,850	N.A.	N.A.	5,960	3,300	1,150	2,000	800	280	N.A.	N.A.
1973	13,000	7,300	6,900	5,400	3,000	1,200	1,600	810	350	160	350
1974	13,000	8,400	6,500	5,400	3,200	1,200	1,400	670	360	270	310
1975	14,000	8,300	6,400	5,300	2,600	1,200	1,300	620	400	280	300
1976	15,000	8,400	7,200	5,300	2,800	1,200	1,400	620	400	310	230
1977	16,000	8,700	7,800	5,300	3,000	1,200	1,000	630	390	200	150

Data include selected big game animals on National Forests and National Grasslands.
N.A.—Not Available.

Sources: U.S. Department of Agriculture, Forest Service, Division of Wildlife Management, *Annual Wildlife Report, 1977,* and previous annual issues.

Table A–29

Continental Waterfowl Population Levels, 1955–77

(in millions)

Species	Population Component Measured	Recent Population Range [a]	1978 Population Level	Population Trend [a,b]
Ducks				
Mallard	Breeding	5.9–12.9	7.6	V–D
Gadwall	Breeding	0.7–2.1	2.0	S
Wigeon	Breeding	2.2–3.8	3.8	S
Green-winged teal	Breeding	1.1–3.2	3.0	S
Blue-winged teal	Breeding	3.7–6.4	4.5	S
Shoveler	Breeding	1.4–2.5	2.2	S
Pintail	Breeding	4.1–10.5	5.7	V–D
Redhead	Breeding	0.4–1.0	0.8	V–S
Canvasback	Breeding	0.4–0.7	0.4	V–S
Scaup	Breeding	5.4–9.5	7.1	I
Canada geese				
Atlantic flyway	Post-season	0.68–0.92	0.80	I
Mississippi flyway	Post-season	0.50–1.07	1.09	I
Central flyway	Post-season	0.16–0.59	0.58	V–I
Pacific flyway	Post-season	0.20–0.49	0.43	V–I
Snow geese				
Atlantic flyway	Post-season	0.03–0.13	0.10	I
Mississippi flyway	Post-season	0.28–0.94	0.80	S
Central flyway	Post-season	0.36–1.21	1.20	I
Pacific flyway	Post-season	0.24–0.51	0.24	S
Ross' geese	Post-season	0.02–0.04	0.03	S
White-fronted geese				
Central flyway	Spring	0.08–0.34	0.34	I
Pacific flyway	Post-season	0.05–0.20	0.11	V–D
Brant				
Atlantic flyway	Post-season	0.04–0.15	0.05	D
Pacific flyway	Post-season	0.12–0.16	0.16	V–D
Whistling swan				
Atlantic flyway	Post-season	0.06–0.08	0.07	I
Pacific flyway	Post-season	0.03–0.08	0.05	S

[a] Generally for period 1955–77, except 1969–78 for geese. Breeding population estimates based on May breeding ground surveys. Most estimates include adjustment for unseen birds, and therefore, represent actual numbers of birds.

[b] I=Increase; D=Decrease; S=Stable; V=Variable/fluctuating.

Source: U.S. Department of the Interior, Fish and Wildlife Service, Office of Migratory Bird Management, unpublished data.

Table A–30

Endangered and Threatened Species in the United States, 1979

Category	Number of Endangered Species [a]			Number of Threatened Species [b]		
	U.S. [c]	Foreign [d]	Total	U.S. [c]	Foreign [d]	Tota
Mammals	33	227	260	3	18	21
Birds	67	144	211	3		3
Reptiles	11	48	59	10		10
Amphibians	5	9	14	2		2
Fishes	29	10	39	12		12
Snails	2	1	3	5		5
Clams	23	2	25			
Crustaceans	1		1			
Insects	6		6			
Plants	21		21	2		2
Total	198	441	639	39	18	57

Number of species currently proposed: 158 animals 1,850 plants (approx.)
Number of Critical Habitats listed: 34
Number of Recovery Teams appointed: 68
Number of Recovery Plans approved: 22
Number of Cooperative Agreements signed with States: 23

Data as of April 30, 1979.

[a] An endangered species is one that is in danger of becoming extinct throughout all or a significant part of its natural range.

[b] A threatened species is one that is likely to become endangered in the foreseeable future.

[c] Includes 50 states and all U.S. territories.

[d] Foreign species are those living outside the U.S. and its territories. Their number, as determined by the U.S. Department of the Interior, Fish and Wildlife Service, includes those listed by the International Trade Convention in Endangered Species, the International Union for Conservation of Nature and Natural Resources, and those species that are generally accepted in the biological community as being endangered or threatened.

Source: U.S. Department of the Interior, Fish and Wildlife Service, *Endangered Species Technical Bulletin,* May 1979, Volume IV, No. 5, p. 8.

Table A–31

Population Characteristics and Toxic Residues in Brown Pellicans in South Carolina, 1969–76

Year	Population Characteristics			Toxic Residues[a]			
	Number of Nests	Number of Young Fledged	Number of Young Fledged Per Nest	Number of Eggs in Sample[b]	DDT[c] (ppm)	Dieldrin (ppm)	PCBs (ppm)
1969	1266	980	0.78	15	7.81	1.16	6.11
1970	1116	945	0.85	13	5.27	0.82	5.25
1971	1469	1349	0.92	65	3.20	0.46	6.49
1972	1415	970	0.69	72	3.69	0.45	7.51
1973	1646	2726	1.66	104	2.56	0.45	4.75
1974	1670	1625	0.97	115	2.72	0.58	7.63
1975	2400	1800	0.75	102	1.80	0.40	6.45
1976	2540	3137	1.23	N.A.	N.A.	N.A.	N.A.

N.A.—Not Available.

Areas studied in South Carolina were Marsh Island in the Cape Romain National Wildlife Refuge and Deveaux Bank. Concentrations of toxic residues are in eggs.

[a] Geometric mean concentration in eggs, parts per million.
[b] Addled and viable eggs in all stages of incubation were collected.
[c] Includes DDT and all its derivatives.

Sources: Laurence J. Blus, Thain G. Lamont, and Burkett S. Neely, Jr., U.S. Fish and Wildlife Service, "Effects of Organochlorine Residues on Eggshell Thickness, Reproduction, and Population Status of Brown Pelicans in South Carolina and Florida, 1969–1976," *Pesticides Monitoring Journal*, Volume 12, No. 4, (Washington, D.C.: U.S. Government Printing Office, March 1979), Tables 1 and 9, pp. 173 and 182.

Table A–32

Nuclear Power Capacity and Generation, 1957–78

Year	Year-End Operating Reactors [a]	Year-End Capacity [a] Million Kilowatts	Electricity Generation	
			Billion Kilowatt Hours	Percent of Total U.S. Generation
1957	1	0.1	[b]	[c]
1958	1	0.1	0.2	[c]
1959	1	0.1	0.2	[c]
1960	2	0.3	0.5	0.1
1961	3	0.4	1.7	0.2
1962	4	0.7	2.3	0.3
1963	7	0.7	3.2	0.4
1964	9	0.9	3.3	0.3
1965	10	0.9	3.7	0.4
1966	11	1.9	5.5	0.5
1967	10	2.9	7.7	0.6
1968	10	2.8	12.5	0.9
1969	13	4.0	13.9	1.0
1970	19	6.5	21.8	1.4
1971	21	8.7	38.1	2.4
1972	29	15.3	54.1	3.1
1973	37	21.0	83.3	4.5
1974	48	31.6	114.0	6.1
1975	51	39.8	172.5	9.0
1976	59	42.9	191.1	9.4
1977	68	49.9	250.9	11.8
1978	71	53.5	276.4	12.5

[a] Includes plants shut down permanently or for extended periods, most of which were tests for prototype units.
[b] Less than 0.05 billion kilowatt hours.
[c] Less than 0.05 percent.
All data include electric utility plants only.

Source: U.S. Department of Energy, Energy Information Administration, *Annual Report to Congress 1978, Volume Two: Data* (Washington, D.C.: U.S. Government Printing Office, 1979), Table 56, p. 135.

Table A–33

U.S. Energy Consumption, by Fuel Type, 1948–78

Year	Coal [a]		Natural Gas [b] (dry)		Petroleum [c]		Hydropower [d]		Nuclear Power		Geothermal [e] and Other		Net Imports of Coke		Total Gross energy Consumption	Change From Previous Year
	Quadrillion Btu	Million Short Tons	Quadrillion Btu	Trillion Cubic Feet	Quadrillion Btu	Million Barrels	Quadrillion Btu	Billion kWh	Quadrillion Btu	Billion kWh	Quadrillion Btu	Billion kWh	Quadrillion Btu	Thousand Short Tons	Quadrillion Btu	Percent [f]
1948	14.86	570.1	4.90	4.74	11.81	2,086	1.40	88.7	0	0	0	0	−0.01	−545	32.96	—
1949	12.60	483.2	5.15	4.97	11.89	2,104	1.45	96.4	0	0	0	0	−0.01	−269	31.07	−5.7
1950	12.89	494.1	5.97	5.77	13.32	2,357	1.44	102.7	0	0	0	0	0	40	33.62	8.2
1951	13.20	505.9	7.05	6.81	14.43	2,561	1.46	106.8	0	0	0	0	−0.02	−865	36.11	7.4
1952	11.84	454.1	7.55	7.29	14.96	2,661	1.50	112.0	0	0	0	0	−0.01	−479	35.83	−0.8
1953	11.87	454.8	7.91	7.64	15.57	2,774	1.44	111.6	0	0	0	0	−0.01	−363	36.78	2.6
1954	10.17	390.0	8.33	8.05	15.85	2,831	1.39	114.0	0	0	0	0	−0.01	−272	35.73	−2.8
1955	11.52	447.0	9.00	8.69	17.26	3,086	1.41	120.4	0	0	0	0	−0.01	−405	39.18	9.6
1956	11.72	456.9	9.61	9.29	17.95	3,212	1.49	129.7	0	0	0	0	−0.01	−525	40.76	4.0
1957	11.14	434.5	10.19	9.85	17.94	3,215	1.56	136.9	0	0	0	0	−0.02	−704	40.81	0.1
1958	9.83	385.7	10.66	10.30	18.54	3,328	1.63	147.0	(*)	0.2	0	0	−0.01	−271	40.66	−0.4
1959	9.79	385.1	11.72	11.32	19.27	3,467	1.59	144.8	(*)	0.2	0	0	−0.01	−337	42.36	4.2
1960	10.12	398.0	12.39	11.97	19.92	3,586	1.65	153.6	0.01	0.5	0	0	−0.01	−227	44.08	4.1
1961	9.89	390.3	12.93	12.49	20.22	3,641	1.68	157.5	0.02	1.7	0	0	−0.01	−318	44.72	1.5
1962	10.18	402.2	13.73	13.27	21.05	3,796	1.82	172.2	0.03	2.3	0	0	−0.01	−222	46.80	4.6
1963	10.69	423.5	14.40	13.97	21.70	3,921	1.77	169.0	0.04	3.2	0	0	−0.01	−298	48.60	3.9
1964	11.25	445.7	15.29	14.81	22.30	4,034	1.91	182.2	0.04	3.3	0	0	−0.01	−421	50.77	4.5

1965	11.89	472.0	15.77	15.28	23.25	4,202	2.06	197.0	0.04	3.7	0	0	−0.02	−744	52.99	4.4
1966	12.48	497.7	17.00	16.45	24.13	4,411	2.07	199.1	0.06	5.5	0	0	−0.03	−1,006	55.72	5.2
1967	12.24	491.4	17.94	17.39	25.28	4,585	2.35	224.9	0.09	7.7	0	0	−0.02	−618	57.88	3.9
1968	12.66	509.9	19.21	18.63	26.98	4,902	2.35	225.9	0.14	12.5	0	0	−0.02	−698	61.32	5.9
1969	12.72	516.4	20.68	20.06	28.34	5,160	2.66	254.6	0.15	13.9	0	0	−0.04	−1,456	64.51	5.2
1970	12.66	523.2	21.80	21.14	29.52	5,364	2.65	252.1	0.24	21.8	0.02	0.9	−0.06	−2,325	66.82	3.6
1971	12.01	501.5	22.47	21.79	30.56	5,553	2.86	272.8	0.41	38.1	0.02	0.9	−0.03	−1,335	68.30	2.2
1972	12.45	524.2	22.70	22.10	32.95	5,990	2.94	283.4	0.58	54.1	0.04	1.8	−0.03	−1,047	71.63	4.9
1973	13.30	562.6	22.51	22.05	34.84	6,317	3.01	289.5	0.91	83.5	0.05	2.3	−0.01	−317	74.61	4.2
1974	12.88	558.4	21.73	21.22	33.05	6,078	3.31	316.8	1.27	114.0	0.06	2.7	0.06	2,262	72.35	−3.0
1975	12.82	562.6	19.95	19.54	32.73	5,958	3.22	309.1	1.90	172.5	0.07	3.4	0.01	546	70.71	−2.3
1976	13.73	603.8	20.35	19.95	34.83	6,391	3.07	295.5	2.11	191.1	0.08	3.9	0	−4	74.16	4.9
1977	14.14	625.7	19.93	19.52	37.18	6,727	2.52	241.4	2.70	250.9	0.08	4.1	0.02	588	76.56	3.2
1978 [h]	14.09	623.5	19.82	19.41	37.79	6,838	3.15	301.6	2.98	276.4	0.07	3.3	0.13	5,029	78.01	1.9

[a] Includes bituminous coal and lignite and anthracite coal.
[b] Excludes natural gas plant liquids.
[c] Domestic demand for refined petroleum products which includes natural gas plant liquids and crude oil burned as fuel.
[d] Includes electric utility and industrial generation of hydropower and net electricity imports.
[e] Includes wood, refuse, and other vegetal fuels used for electric generation. The geothermal portion of this item is converted to Btu by applying the geothermal conversion factor; the "other" portion is converted by applying national average heat rates for fossil fuel steam electric plants.
[f] Percent change calculated from reported data prior to rounding.
[g] Less than 0.005 quadrillion Btu.
[h] Preliminary.

Note: Sum of components may not equal total due to independent rounding.

Source: U.S. Department of Energy, Energy Information Administration, *Annual Report To Congress 1978, Volume Two: Data* (Washington, D.C.: U.S. Government Printing Office, 1979), Table 3, p. 7.

Table A–34

U.S. Energy Production, by Fuel Type, 1948–78

Year	Coal [a]		Natural Gas [b] (dry)		Petroleum [c]		Natural Gas Plant Liquids		Hydropower		Nuclear Power		Geothermal and Other [d]		Total Gross Energy Production	Change From Previous Year
	Quadrillion Btu	Million Short Tons	Quadrillion Btu	Trillion Cubic Feet	Quadrillion Btu	Million Barrels	Quadrillion Btu	Million Barrels	Quadrillion Btu	Billion kWh	Quadrillion Btu	Billion kWh	Quadrillion Btu	Billion kWh	Quadrillion Btu	Percent [e]
1948	17.12	656.7	5.11	4.94	11.72	2,020	0.67	147	1.37	87.0	0	0	0	0	35.99	—
1949	12.53	480.6	5.38	5.20	10.68	1,842	0.71	157	1.42	94.7	0	0	0	0	30.73	−14.6
1950	14.62	560.4	6.23	6.02	11.45	1,974	0.82	182	1.41	100.8	0	0	0	0	34.54	12.4
1951	15.04	576.3	7.42	7.17	13.04	2,248	0.92	205	1.42	104.4	0	0	0	0	37.83	9.5
1952	13.23	507.4	7.96	7.69	13.28	2,290	1.00	224	1.47	109.7	0	0	0	0	36.94	−2.4
1953	12.74	488.2	8.35	8.06	13.67	2,357	1.06	239	1.41	109.6	0	0	0	0	27.23	0.8
1954	10.98	420.8	8.68	8.39	13.43	2,315	1.11	252	1.36	111.7	0	0	0	0	35.56	−4.5
1955	12.72	490.8	9.34	9.03	14.41	2,484	1.24	281	1.36	116.3	0	0	0	0	39.08	9.9
1956	13.72	529.8	10.00	9.66	15.18	2,617	1.28	293	1.43	125.2	0	0	0	0	41.62	6.5
1957	13.42	518.0	10.60	10.25	15.18	2,617	1.29	295	1.52	133.3	0	0	0	0	42.00	0.9
1958	11.18	431.6	10.94	10.57	14.20	2,449	1.29	295	1.59	143.7	[f]	0.2	0	0	39.21	−6.6
1959	11.08	432.7	11.95	11.55	14.93	2,575	1.38	321	1.55	141.2	[f]	0.2	0	0	40.90	4.3
1960	11.12	434.3	12.66	12.23	14.93	2,575	1.46	340	1.60	149.1	0.01	0.5	0	0	41.78	2.1
1961	10.73	420.4	13.11	12.66	15.21	2,622	1.55	362	1.65	155.2	0.02	1.7	0	0	42.27	1.2
1962	11.21	439.0	13.72	13.25	15.52	2,676	1.59	373	1.81	171.7	0.03	2.3	0	0	43.88	3.8
1963	12.15	477.2	14.51	14.08	15.97	2,753	1.71	401	1.77	169.0	0.04	3.2	0	0	46.15	5.2

1964	12.83	504.2	15.30	14.82	16.16	2,787	1.80	422	1.89	180.3	0.04	3.3	0	0	48.02	4.1
1965	13.38	527.0	15.78	15.29	16.52	2,849	1.88	442	2.06	197.0	0.04	3.7	0	0	49.66	3.4
1966	13.82	546.8	17.01	16.47	17.56	3,028	2.00	469	2.06	198.0	0.06	5.5	0	0	52.51	5.7
1967	14.19	564.9	17.94	17.39	18.65	3,216	2.18	514	2.35	224.9	0.09	7.7	0	0	55.40	5.5
1968	13.93	556.7	19.07	18.49	19.31	3,329	2.32	550	2.35	225.9	0.14	12.5	0	0	57.12	3.1
1969	14.20	571.0	20.45	19.83	19.56	3,372	2.42	580	2.65	253.5	0.15	13.9	0	0	59.43	4.0
1970	15.05	612.7	21.67	21.02	20.40	3,517	2.51	606	2.63	250.1	0.24	21.8	0.02	0.9	62.51	5.2
1971	13.59	560.9	22.28	21.61	20.03	3,454	2.54	618	3.11	296.3	0.41	38.1	0.02	0.9	61.98	−0.8
1972	14.49	602.5	22.21	21.62	20.04	3,455	2.60	638	2.86	275.7	0.58	54.1	0.04	1.8	62.81	1.3
1973	14.39	598.6	22.19	21.73	19.49	3,361	2.57	634	2.86	275.2	0.91	83.5	0.05	2.3	62.46	−0.6
1974	14.47	610.0	21.21	20.71	18.57	3,203	2.47	616	3.17	304.0	1.27	114.0	0.06	2.7	61.23	−2.0
1975	15.19	654.6	19.64	19.24	17.73	3,057	2.37	596	3.15	302.9	1.90	172.5	0.07	3.4	60.06	−1.9
1976	15.85	684.9	19.48	19.10	17.26	2,976	2.33	587	2.98	286.9	2.11	191.1	0.08	3.9	60.09	0.1
1977	e 15.90	e 694.8	19.57	19.16	17.45	3,009	2.33	590	2.34	224.0	2.70	250.9	0.08	4.1	e 60.37	0.5
1978 e	15.11	660.2	19.27	18.88	18.35	3,164	2.26	573	2.97	284.2	2.98	276.4	0.07	3.3	61.00	1.0

[a] Includes bituminous coal and lignite and anthracite coal.
[b] Excludes natural gas plant liquids.
[c] Includes crude oil and lease condensate.
[d] Includes wood, refuse, and other vegetal fuels for electricity generation. The geothermal portion of this item is converted to Btu by applying the geothermal conversion factor; the "other" portion is converted by applying national average heat rates for fossil fuel steam electric plants.
[e] Percent change calculated from reported data prior to rounding.
[f] Less than 0.005 quadrillion Btu.
[g] Preliminary.

Note: Sum of components may not equal total due to independent rounding.

Source: U.S. Department of Energy, Energy Information Administration, *Annual Report to Congress 1968, Volume Two: Data* (Washington, D.C.: U.S. Government Printing Office, 1979), Table 2, p. 5.

Table A–35

U.S. Coal Production, by Underground and Surface Mining, 1900–78

(in millions of short tons)

Year	Total	Underground	Surface *	Year	Total	Underground	Surface *	Year	Total	Underground	Surface *
1900	270	N.A.	N.A.	1926	656	N.A.	N.A.	1952	510	384	126
1901	293	N.A.	N.A.	1927	596	N.A.	N.A.	1953	486	367	119
1902	302	N.A.	N.A.	1928	575	N.A.	N.A.	1954	420	306	114
1903	357	N.A.	N.A.	1929	608	N.A.	N.A.	1955	491	360	131
1904	352	N.A.	N.A.	1930	536	N.A.	N.A.	1956	528	379	149
1905	393	N.A.	N.A.	1931	442	417	25	1957	515	371	144
1906	414	N.A.	N.A.	1932	360	234	26	1958	532	397	135
1907	480	N.A.	N.A.	1933	383	356	27	1959	431	292	139
1908	416	N.A.	N.A.	1934	416	387	39	1960	435	293	142
1909	461	N.A.	N.A.	1935	425	393	32	1961	421	280	141
1910	502	N.A.	N.A.	1936	491	453	37	1962	440	288	152
1911	496	N.A.	N.A.	1937	499	458	41	1963	479	309	170
1912	534	N.A.	N.A.	1938	495	457	38	1964	505	328	177
1913	570	N.A.	N.A.	1939	448	402	46	1965	528	338	190
1914	513	N.A.	N.A.	1940	441	419	42	1966	545	342	203
1915	531	N.A.	N.A.	1941	516	460	56	1967	561	350	210
1916	590	N.A.	N.A.	1942	581	516	65	1968	553	345	209
1917	651	N.A.	N.A.	1943	652	556	96	1969	569	348	222
1918	678	N.A.	N.A.	1944	684	561	123	1970	610	240	270
1919	552	N.A.	N.A.	1945	731	502	129	1971	563	278	285
1920	658	N.A.	N.A.	1946	594	460	134	1972	535	288	247
1921	505	N.A.	N.A.	1947	685	531	154	1973	558	286	272

1922	476	N.A.	N.A.	1948	649	494	155	1974	566	264	302
1923	656	N.A.	N.A.	1949	479	358	121	1975	611	279	332
1924	570	N.A.	N.A.	1950	562	425	317	1976	647	281	366
1925	581	N.A.	N.A.	1951	574	444	130	1977	665	257	409
								1978 [b]	595	219	376

N.A.—Not Available.
Details may not add to totals due to roundings.
Includes bituminous, anthracite, and lignite.

[a] 1967–1977 includes strip and auger mines, culm banks, and dredges.
[b] Preliminary data.

Sources: (1900–1913) U.S. Department of the Interior, Bureau of Mines, *Coal Mining Fatalities in the U.S., 1870–1914, with Statistics of Coal Production, Labor and Mining Methods by States and Calendar Years*, published 1916, p. 10; (1914–1966) Bituminous Coal Operators, unpublished data; and Pennsylvania Department of the Environment, unpublished data; (1967–1977) U.S. Department of Labor, Mine Safety and Health Administration, *Injury Experience in Coal Mining*, Informational Reports, annual issues; (1978) U.S. Department of Labor, Mine Safety and Health Administration, *Mine Injuries and Worktime Quarterly*, (First Quarter, 1979).

Table A–36

U.S. Deaths from Accidents, by Underground and Surface Coal Mining, 1906–78

Year	Total	Underground [a]	Surface [b]	Year	Total	Underground [a]	Surface [b]	Year	Total	Underground [a]	Surface [b]
1906	2,138	1,960	178	1930	2,063	1,950	113	1955	420	352	68
1907	3,242	3,024	218	1931	1,463	1,378	85	1956	448	390	58
1908	2,445	2,286	159	1932	1,207	1,130	77	1957	478	424	54
1909	2,642	2,492	150	1933	1,064	976	88	1958	358	315	43
1910	2,821	2,637	184	1934	1,226	1,132	94	1959	293	251	42
1911	2,656	2,486	170	1935	1,242	1,144	98	1960	325	274	51
1912	2,419	2,220	199	1936	1,342	1,256	86	1961	294	256	38
1913	2,785	2,624	161	1937	1,413	1,318	95	1962	289	244	45
1914	2,454	2,288	166	1938	1,105	1,027	78	1963	284	245	39
1915	2,269	2,109	160	1939	1,078	1,014	64	1964	242	210	32
1916	2,226	2,076	150	1940	1,388	1,308	80	1965	259	223	36
1917	2,696	2,435	261	1941	1,266	1,166	100	1966	233	194	39
1918	2,580	2,333	247	1942	1,471	1,353	118	1967	222	174	48
1919	2,323	2,135	188	1943	1,451	1,327	124	1968	311	268	43
1920	2,272	2,077	195	1944	1,298	1,166	132	1969	203	149	54
1921	1,995	1,875	120	1945	1,068	960	108	1970	260	206	54
1922	1,984	1,846	138	1946	968	863	105	1171	181	141	40
1923	2,462	2,304	158	1947	1,158	1,047	111	1972	156	122	34
1924	2,402	2,264	138	1948	999	880	119	1973	132	99	33

1925	2,234	2,107	127	1949	585	508	77	1974	133	90	43
1926	2,518	2,400	118	1950	643	547	96	1975	155	111	44
1927	2,231	2,109	122	1951	785	707	78	1976	141	104	37
1928	2,176	2,092	84	1952	548	474	74	1977	139	100	39
1929	2,187	2,076	111	1953	461	409	52	1978	[c] 105	[c] 68	[c] 37
				1954	396	342	54				

From 1901 to 1978, there were 110,938 deaths in the U.S. due to coal mining.

1906–1909: Includes only those states that maintained complete records of fatal injuries. They represent 98–99 percent of the total production of coal in the U.S.

1910–1978: Includes the entire coal industry.

[a] Includes fatalities from roof and face falls, haulage equipment, gas or dust explosions, explosives, electricity, machinery, pressure bumps and bursts, and inrushes of water or material.

[b] Includes fatalities that occurred at all other work locations, including the associated surface works of underground mines, strip mines, culm banks, dredges, and mechanical-cleaning plants. Beginning in 1955, includes fatalities in auger mines.

[c] Preliminary data.

Sources: U.S. Department of Labor, Mine Safety and Health Administration, *Injury Experience in Coal Mining, 1976*, Informational Report No. 1097 (Washington, D.C.; U.S. Government Printing Office, 1979), Table 55, pp. 138–139; U.S. Department of Labor, Mine Safety and Health Administration, unpublished data.

Table A–37

Injury Data for U.S. Coal Mines, 1930–76

Year	Number of Injuries			Frequency (Per million man-hours)			Average Men Working Daily	Production, Short Tons (thousands)
	Fatal	Nonfatal Disabling	Nondisabling	Fatal	Nonfatal Disabling	Nondisabling		
1930	2,063	99,981	N.A.	1.87	90.65	N.A.	644,006	536,911
1931	1,463	77,958	N.A.	1.66	88.26	N.A.	589,705	441,751
1932	1,207	56,283	N.A.	1.73	80.50	N.A.	527,623	359,565
1933	1,064	59,129	N.A.	1.34	74.58	N.A.	523,182	383,172
1934	1,226	65,559	N.A.	1.43	76.63	N.A.	566,426	416,536
1935	1,242	63,426	N.A.	1.52	77.43	N.A.	565,202	424,632
1936	1,342	67,540	N.A.	1.45	72.91	N.A.	584,582	491,139
1937	1,413	66,259	N.A.	1.55	72.62	N.A.	589,856	498,793
1938	1,105	49,636	N.A.	1.59	71.36	N.A.	541,528	395,697
1939	1,078	51,773	N.A.	1.42	68.12	N.A.	539,375	447,977
1940	1,388	57,776	N.A.	1.65	68.75	N.A.	533,267	512,808
1941	1,266	61,057	N.A.	1.37	66.26	N.A.	546,692	569,884
1942	1,471	66,774	N.A.	1.44	65.40	N.A.	530,861	640,021
1943	1,451	64,594	N.A.	1.40	62.44	N.A.	486,516	652,977
1944	1,298	63,691	N.A.	1.20	59.06	N.A.	453,937	684,950
1945	1,068	57,117	N.A.	1.11	59.58	N.A.	437,921	631,523
1946	968	55,350	N.A.	1.10	62.92	N.A.	463,079	593,976
1947	1,158	57,660	N.A.	1.22	60.72	N.A.	490,356	685,162
1948	999	53,472	N.A.	1.11	59.53	N.A.	507,333	650,003
1949	585	35,405	N.A.	.91	55.11	N.A.	485,306	478,920
1950	643	37,264	N.A.	.90	52.38	N.A.	483,239	562,305
1951	785	35,553	N.A.	1.13	50.99	N.A.	441,905	574,960
1952	548	30,074	N.A.	.92	50.66	N.A.	401,329	509,967

1953	461	24,258	N.A.	.90	47.23	N.A.	351,126	486,404
1954	396	17,718	N.A.	1.02	45.67	N.A.	280,705	420,885
1955	420	18,885	N.A.	1.00	45.03	N.A.	260,089	491,468
1956	448	19,816	N.A.	1.03	45.69	N.A.	260,285	528,447
1957	478	18,792	N.A.	1.17	46.04	N.A.	254,725	514,706
1958	358	14,160	N.A.	1.11	43.94	N.A.	224,890	432,196
1959	293	12,163	N.A.	.99	41.09	N.A.	203,597	432,574
1960	325	11,902	N.A.	1.15	42.28	N.A.	189,679	435,086
1961	294	11,197	N.A.	1.15	43.86	N.A.	167,568	420,729
1962	289	10,944	N.A.	1.16	43.96	N.A.	161,286	439,972
1963	284	11,133	N.A.	1.12	43.97	N.A.	157,126	478,629
1964	242	11,070	N.A.	.96	43.86	N.A.	150,761	505,573
1965	259	11,138	N.A.	1.04	44.73	N.A.	148,734	527,993
1966	233	10,446	N.A.	.96	42.85	N.A.	145,244	545,464
1967	222	10,115	N.A.	.92	41.84	N.A.	139,312	560,764
1968	311	9,639	N.A.	1.33	41.12	N.A.	134,467	553,340
1969	203	9,917	N.A.	.85	41.76	N.A.	133,302	569,182
1970	260	11,552	N.A.	1.00	44.40	N.A.	144,480	609,803
1971	181	11,916	N.A.	.71	46.89	N.A.	142,108	562,720
1972	156	12,329	16,090	.58	46.08	60.14	162,207	534,586
1973	132	11,220	14,491	.48	40.41	52.20	147,243	557,949
1974	133	8,545	7,267	.45	28.79	24.49	176,997	565,774
1975	155	11,107	9,641	.42	30.17	26.18	218,162	611,130
1976	141	14,389	12,768	.37	37.55	33.32	214,632	647,087

N.A.—Not Available.

Source: U.S. Department of Labor, Mine Safety and Health Administration, *Injury Experience in Coal Mining, 1976* (Washington, D.C.: U.S. Government Printing Office, 1979), Informational Report 1097, Table 51, p. 131.

Table A–38

Surface Land Used and Reclaimed by the Coal Mining Industry, 1930–77

Use	1930–1971 [a]				1930–1977 [b]			
	Land Used		Land Reclaimed		Land Used		Land Reclaimed	
	Thousands of Acres	Percent of Total Land Used	Thousands of Acres	Percent of Total Land Used	Thousands of Acres	Percent of Total Land Used	Thousands of Acres	Percent of Total Land Used
Surface mining [c]	966.0	61.5	716.0	45.6	[d] 1,805.9	[d] 89.9	[d] 1,452.1	[d] 63.9
Disposal of overburden and other mine waste from surface mining	320.0	20.4	268.0	17.1	(•)	(•)	(•)	(•)
Disturbed as a result of underground workings	87.9	5.6	4.0	0.3	N.A.	N.A.	N.A.	N.A.
Disposal of underground mine waste	166.0	10.6	20.0	1.3	164.2	8.2	22.5	1.0
Disposal of coal-cleaning plant wastes	31.9	2.0	6.5	0.4	38.9	1.9	9.0	0.4
Total, All Uses	1,570.0	100.0	3,010.0	64.3	2,009.0	100.0	1,483.6	65.3

N.A.—Not Available.
Excludes state and private reclamation efforts.
Details may not add to totals due to rounding.

[a] Includes bituminous, lignite, and anthracite coal and peat. Bituminous coal and lignite account for about 98 percent of the land area used.
[b] Preliminary data. Includes bituminous coal and lignite only.
[c] Area of excavation only.
[d] Includes Disposal of Overburden and Other Mine Waste from Surface Mining.
[e] Included in Surface Mining.

Sources: (1930–1971) U.S. Department of the Interior, Bureau of Mines, *Land Utilization and Reclamation in the Mining Industry, 1930–1971*, Bureau of Mines Information Circular 8642, 1974, p. 16; (1930–1977) U.S. Department of the Interior, Bureau of Mines, unpublished data.

APPENDIX B

THE PRESIDENT'S MESSAGE TO THE CONGRESS ON ENVIRONMENTAL PRIORITIES AND PROGRAMS, AUGUST 1979

Four months after I took office, I presented to the Congress a comprehensive Message on the Environment, a charter for the first years of my Administration. Building on the record of the Congress in the 1970's, I sought both to protect our national heritage and to meet the competing demands on our natural resources.

Certain basic ideas remain the foundation of American environmental policy. Our great natural heritage should be protected for the use and enjoyment of all citizens. The bounty of nature—our farmlands and forests, our water, wildlife, and fisheries, our renewable energy sources—are the basis of our present and future material well-being. They must be carefully managed and conserved. The quality of our environment must be nurtured by wise decisions and protected from hasty or unplanned actions. Clean air and water remain essential goals, and we intend to achieve them in the most efficient and effective ways possible. And we have a serious responsibility to help protect the long-term health of the global environment we share with all humanity.

I am proud of the achievements of this period. The program I offer today emphasizes continuity, but it also reflects a keener awareness of certain serious emerging problems—such as disposition of the toxic wastes our highly technological society produces.

ACCOMPLISHMENTS SINCE 1977

We have made great strides together since I took office. With my strong support, the Congress enacted and I signed into law:

- the 1977 Amendments to our two fundamental laws for cleaning up pollution, the Clean Air and Clean Water Acts, including strict but enforceable standards and a strong wetlands protection program;
- the 1977 Surface Mining Reclamation Act, which established the first federal environmental standards for coal mining, and under which regulations were developed with strong public involvement;
- the 1977 Federal Mine Safety and Health Act, which established the Mine Safety and Health Administration in the Department of Labor to promulgate and enforce health and safety standards in all mines;
- the 1977 Nuclear Non-Proliferation Act, which sets conditions on U.S. nuclear exports to deter the spread of nuclear weapons, and offers other countries incentives to cooperate with our safeguards against proliferation;
- indefinite deferral of other activities which might lead to weapons proliferation, particularly nuclear fuel reprocessing and commercialization of the breeder reactor;

- the 1978 National Energy Act, with specific policies and programs emphasizing energy conservation;
- the 1978 Federal Environmental Pesticide Control Act, which provided for generic registration and control of pesticides;
- reauthorization, in 1978, of the Endangered Species Act, including new procedures for resolving conflicts under the Act;
- enactment of the National Parks and Recreation Act of 1978 and other legislation to preserve nationally significant areas, adding 45 million acres to the National Park System, 13 new Wild and Scenic Rivers and National Trails, and protecting more than 4.5 million additional acres of wilderness.

In addition, I issued Executive Orders in 1977 and 1978 directing federal agencies to improve their implementation of the National Environmental Policy Act under new regulations, which were issued in 1978; examine the environmental effects of federal actions abroad; preserve and restore natural values of wetlands and floodplains; protect our public lands from damage caused by off-road vehicles; and analyze the impacts of new federal policies on urban areas. These directives are being implemented.

ENVIRONMENTAL PROGRAM

With these accomplishments behind us, we can turn our attention to new issues and to other key issues that are still unresolved.

In the decade ahead, we will face difficult decisions as we confront the necessity of reducing dangerous dependence on foreign oil. The leaders of the major industrial democracies met in Tokyo last month to chart a course that would help cut the use of imported oil from uncertain foreign suppliers. Each nation committed itself to a specific reduction in imports, to be accomplished in a way appropriate to its particular needs and resources.

For the past two and one-half years, conservation and energy from the sun have been major thrusts of my energy program. Solar energy funding has been tripled during that period and the Congress in 1978 enacted the National Energy Act which will save 2.5 million barrels of imported oil per day. Much of these savings will be accomplished with conservation initiatives. In addition, another 1.5 million barrels of imported oil will be saved as a result of my April energy message and June solar energy package.

To build on these major savings, I have proposed an expanded effort to put this nation on a sound energy footing, with clear goals for the next decade. That effort is based on a bold program to increase domestic energy production and on additional energy conservation initiatives. Overall, this program will reduce our dependence on foreign oil by 4.5 million barrels per day by 1990.

Some of the measures I have proposed will simultaneously serve the goals of reducing oil imports and enhancing our environment. I proposed establishing a major new residential and commercial conservation program designed to save at least 500,000 barrels of oil a day by 1990. I further proposed a total of $16.5 billion over the coming decade for improvements in the nation's public transportation system and in transportation fuel efficiency. A major solar energy program will help us to meet our goal of 20 percent solar energy by the year 2000.

We must also embark on a major energy production effort through a new Energy Security Corporation that will have broad responsibility for developing 2.5 million barrels a day of replacement fuels by 1990. That Corporation wil be specifically authorized to develop not only synthetic fuels but also sources of energy which could have significant environmental benefits, such as natural gas and biomass. I do not pretend that all new replacement sources of energy will be environmentally innocuous. Some of the new technologies we will need to develop pose environmental risks, not all of which are yet fully understood. I will work to ensure that environmental protections are built into the process of developing these technologies, and that when tradeoffs

must be made, they will be made fairly, equitably, and in the light of informed public scrutiny. We will examine not only the impact of new energy technologies on land and water and the effects of toxic chemicals, but also the longer term implications of increasing carbon dioxide concentration in the atmosphere.

I am pledged to be sensitive both to energy needs and to environmental considerations. There is no excuse for unnecessary red tape, which has plagued construction of some needed energy projects. I have proposed the creation of an Energy Mobilization Board to accelerate decision making on critical energy facilities. This will cut out excessive delay, but I will not allow it to undermine protection of our nation's environment. I intend, for instance, to make the environmental impact statement process fit the decision schedule set by the Energy Mobilization Board so that waivers of these statements will be rare. Only in exceptional cases will alternative procedures be necessary for the orderly completion of a critical energy facility. With the exception of new requirements imposed when construction of a critical facility is underway, the Board could not waive substantive environmental standards. The President will maintain the right to override decisions of the Board on any waiver issue, and Board waiver decisions would be subject to judicial review.

Solving the nation's energy problem is essential to our economy and our security. We will not lose sight of our other goals but we must not fail in ending the energy crisis. This Administration's basic commitment to clean air, clean water and the overall protection of the environment remains strong.

ALASKA LANDS

The highest environmental priority of my Administration is the passage of adequate legislation designating National Parks, Wildlife Refuges, Wilderness Areas, National Forests, and Wild and Scenic Rivers in Alaska.

To protect these magnificent Alaskan lands, I took several actions after the 95th Congress failed to provide protection against exploitation of certain areas in Alaska. By executive action, I designated 17 areas as National Monuments, covering 56 million acres. Additional areas were set aside by the Secretaries of Interior and Agriculture. These areas should be promptly and permanently protected by legislation.

The legislation I support not only protects Alaska's natural and cultural heritage but also accommodates the need for balanced development of Alaska's natural resources. Under the Alaska Statehood Act and Native Claims Settlement Act, federal land comprising an area nearly as large as Texas will soon be in state, native and private ownership. My proposals leave most of Alaska's mineral and timber wealth available for development, both on federal and nonfederal lands. In particular, all of the off-shore and 95 percent of the on-shore areas in Alaska with favorable potential for oil and gas would be open to exploration and development.

The only area with significant potential for oil and gas reserves that would be foreclosed from exploration and development is the Arctic Wildlife Refuge, the calving grounds of the largest remaining caribou herd in the world and an important part of the herd's migratory route. Because of our responsibility to protect this extraordinary remnant of our continent's original wildlife, and because oil and gas are plentifully available elsewhere in Alaska, I firmly believe that the Arctic Wildlife Refuge deserves the full protection the House bill would provide.

There are other Alaskan areas where disagreements and conflicts exist over proper management. The Administration's proposals strike a balance that offers future generations of all Americans—especially Alaskans—broad opportunities for prosperity and enjoyment without the mistakes in land management we have seen elsewhere in the country.

I applaud the recent passage by the House of Representatives, by a margin of 300 votes, of a strong and fair bill which will protect Alaska's wildlife and

wild areas, while providing for America's future economic needs. I urge the Senate to act with equal foresight this session.

HAZARDOUS WASTES

In August 1978, I declared Love Canal in Niagara Falls, New York, a national disaster, thus authorizing the use of federal disaster relief aid. The tragedy of Love Canal exemplifies the legacy of past improper hazardous waste disposal.

Last month I submitted to Congress a legislative proposal designed to prevent future disasters like the one at Love Canal. My proposed legislation—the Oil, Hazardous Substances and Hazardous Waste Response, Liability and Compensation Act—will provide the first comprehensive program to address releases of oil and hazardous substances from spills and from inactive and abandoned sites into navigable waters, ground waters, land, and air. The legislation builds on present authority and fills gaps where present authority is inadequate to protect the human environment.

We do not yet know all of the problems associated with the disposal of hazardous wastes, but we must take further steps immediately. A report done for the Environmental Protection Agency estimates that there are 33,000-50,000 dumpsites which may contain some hazardous wastes. Of these, EPA estimates that 1,200 to 2,000 may present potentially significant problems, and 500 to 800 of them may have to be abandoned. Other accounts of improper disposal describe shallow burial in steel drums which leak after years in the ground, dumping in open lagoons, and clandestine dumping in sewers and along our highways. These abuses have caused serious damage to human health and economic welfare, pollution of ground and drinking water, and degradation of residential and recreation areas. The cost of cleaning up these sites runs into the billions of dollars. But the costs of ignoring the problem would be far higher.

Timely action by the Congress on my program will enable the Federal government, in cooperation with State and local governments and industry to:

- identify abandoned hazardous dump sites across the nation;
- establish a uniform system of reporting spills and releases;
- provide emergency government response and containment to clean up and mitigate pollution without delay in cases where those responsible do not respond adequately or cannot be quickly identified;
- provide vigorous investigation of releases of oil, hazardous substances or hazardous waste from spills or abandoned and inactive sites;
- provide stronger authority to compel the responsible parties to clean up dangerous sites wherever possible;
- provide compensation for damages to property and for some other economic losses resulting from spills; and
- provide financing for these actions through a national fund of appropriations and a fee on the oil and chemical industries, and State cost-sharing over certain limits.

SOLAR ENERGY

My Solar Energy Message, submitted to the Congress on June 20, 1979, calls for a national commitment to the use of solar energy. That message and the program it lays out came from a 13-month effort by my Administration and the public, begun on Sun Day—May 3, 1978.

Solar energy is renewable and secure. It is clean and safe. In the long run, solar and other renewable sources of energy provide a hedge against inflation. Unlike the costs of depletable resources, which rise at increasing rates as reserves are consumed, the cost of energy from the sun will go *down* as we

develop better and cheaper ways of applying it to everyday needs. For everyone in our society—especially our low-income or fixed-income families—solar energy will provide an important way to avoid rising fuel costs in the future. No foreign cartel can embargo the sun or set the price of the energy we harness from it.

I have set a national goal of achieving 20 percent of the Nation's energy from the sun and other renewable resources by the year 2000. To do this we must commit ourselves to several major new initiatives which will hasten the introduction of solar technologies. I am proposing a variety of solar programs to be funded from my proposed Energy Security Trust Fund, including a Solar Bank to help finance solar installations in homes and commercial buildings; tax credits for new buildings that use solar energy and for using the sun's heat for industrial and agricultural processes; and stronger efforts to remove institutional, financial, and information barriers that currently inhibit the use of solar energy by citizens. These proposals are in addition to the expanded research, development and demonstration program I included in my budget for fiscal year 1980.

NUCLEAR WASTE MANAGEMENT AND SAFETY

I will soon announce a national nuclear waste management policy that will be designed to deal effectively with nuclear wastes from all sources, including commercial, defense, medical, and research activities. This nuclear waste management policy will be based primarily on recommendations presented to me by the Interagency Review Group on Nuclear Waste Management. Some of the important findings of that Report include the following:

- Existing and future nuclear waste from military and civilian activities, including discarded spent fuel from the once-through nuclear fuel cycle, should be isolated from the biosphere so that it does not pose a significant threat to public health and safety.
- The responsibility for establishing a waste program should not be deferred to future generations.
- A broader research and development program for waste disposal, particularly geologic isolation, should begin promptly.
- Public participation should be developed and strengthened for all aspects of nuclear waste management programs.

I also look forward to receiving the recommendations on reactor safety from the Kemeny Commission in the aftermath of the Three Mile Island accident so that we can assure that nuclear reactors are as safe as the public expects them to be.

WATER RESOURCES POLICY

I remain firmly committed to the water resources policy reforms I announced in my Message to Congress one year ago. The revised criteria used by the Administration in reviewing proposed water projects have already shown their worth. They are producing environmental benefits and reducing wasteful government spending. In 1979, for the first time in four years, the Executive branch proposed funding new water projects, using the more systematic and objective evaluation procedures I have instituted. With the help of Congress and State and local governments, the Administration has prepared legislation to make further reforms in water resources management, including cost-sharing and assistance to states for comprehensive water resources planning. I look forward to cooperation with the 96th Congress in this area.

NATIONAL HERITAGE POLICY ACT

I strongly support the establishment of a comprehensive federal program to identify and protect significant natural areas and historic places. I will soon propose a National Heritage Policy Act which would help federal agencies, state and local governments, Indian tribes and citizens identify potential heritage areas; establish a new National Register of Natural Areas to supplement the existing National Register of Historic Places; and protect areas listed on either Register, or eligible for listing, from adverse federal actions. This important legislation would support the Heritage Conservation program already established by the Secretary of the Interior in 1977.

SAVING THE WHALES

With U.S. leadership, the nations of the world are making encouraging progress toward protecting the great whales. At the July 1979 meeting of the International Whaling Commission (IWC), proposals by the United States and other countries for a moratorium on commercial whaling led to dramatic improvements. By the necessary three-fourths majority, IWC members voted to:

- End whaling from factory ships on the high seas (except for hunting of the relatively numerous minkes) and allow whaling only from coastal stations;
- Reduce killing of the commercially valuable but jeopardized sperm whales by more than three-quarters, with world quotas down from 9360 sperm whales to 2203;
- Establish a whale sanctuary in most of the Indian Ocean where no hunting of any of the great whales will be allowed for 10 years.

I am wholeheartedly committed to strong action to guarantee the survival of the great whales. The progress made in this year's IWC meeting shows that many other nations share the American commitment. I will continue to press for better scientific understanding of these magnificent and highly intelligent creatures and will maintain the effort to halt commercial whaling.

IMPLEMENTATION OF 1978 NATIONAL PARKS AND RECREATION ACT

Following passage of the National Parks and Recreation Act of 1978, the Administration has sought to speed the acquisition of new park land before it is spoiled or priced out of reach. We shall continue to do that.

Among the most significant and imaginative actions included in the 1978 legislation is the program to establish a million-acre Pinelands National Reserve in New Jersey. The Department of the Interior will support local and State efforts to protect the Pinelands and its unique scenic and natural resources while maintaining private ownership and a sound local tax base. The Administration strongly supports this new Federal, State and local partnership in the Pinelands, and will work hard to see that federal agencies cooperate with State and local governments to ensure its success.

POLLUTION CONTROL

Making the Clean Air and Clean Water Acts work is an important commitment of my Administration. We will continue the progress we have made in the past two years in promulgating fair standards and regulations, and we will continue to encourage new approaches to control of pollution, such as alternative and innovative waste water treatment projects. The Environmen-

tal Protection Agency has taken a number of steps in the right direction. For example, the "bubble concept," "offset" policy, and permit consolidation are intended to simplify pollution controls.

I will seek the reauthorization of the Safe Drinking Water Act, which expires next year. This law protects our citizens from newly-discovered toxic pollutants within drinking water, as well as imposing standards for conventional contaminants. For toxic substances which may enter the environment in a multitude of ways, my Administration is committed to the reauthorization and vigorous enforcement of the comprehensive Toxic Substances Control Act.

OIL POLLUTION OF THE OCEANS

The recent collision in the Caribbean of two supertanker behemoths, each carrying more than 1.4 million barrels of oil, underscores the importance of effective national and international programs to reduce oil spills. At the outset of my Presidency, I proposed a comprehensive program to reduce the threat of oil pollution from tankers in United States waters, and to win international agreement to higher standards of tanker safety and pollution prevention.

Responding to the U.S. initiative, maritime nations of the world agreed in 1978 to tighten inspection requirements and significantly raise world standards for tanker construction and equipment. The Department of Transportation is completing new rules, based on the international agreement, to require improved features on both U.S. ships and foreign tankers entering our ports, including: segregated ballast, protective location of ballast space, crude oil washing, inert gas systems, and improved emergency steering systems. Dual radars and other aids to navigation are already required.

In addition, for the past two and one-half years, the Coast Guard has boarded and examined at least once a year every foreign-flag tanker entering our ports, recorded any deficiencies, and required repairs if necessary.

The Secretary of Transportation will promptly add to this program requirements for:

- improved construction of tank barges;
- safe conduct of lightering (ship to ship transfer of oil);
- improved U.S. standards for tanker crews and pilots; and
- pollution prevention features for older, smaller tankers not covered by the international standards.

Requirements for collision avoidance aids will also be added; international agreement is near on standards for these important tanker safety devices.

The United States will continue to urge other nations to put into effect promptly the requirements of the 1978 international agreements on tanker safety and pollution prevention. I also urge the prompt adoption by all nations of the new international standards for training and certification of seafarers, agreed upon in 1978.

The proposed Oil, Hazardous Substances and Hazardous Waste Response, Liability and Compensation Act, submitted to the Congress by the Administration, provides for swift clean up of oil spills, strict liability of spillers, and compensation for victims of oil spill damage.

I expect the Coast Guard to report to me promptly on the results of its study of devices to improve tanker maneuverability and stopping. In addition, the Coast Guard is undertaking a study of past accidents to evaluate further the usefulness of double bottoms and side protection in reducing oil spills. The Department of Transportation will continue to evaluate promising ideas to preserve the oceans and its resources from pollution by oil.

REGULATORY REFORM

Improving government regulations is important to my effort to make government more efficient and private-sector responses more cost-effective. Environmental protection can and should benefit. I intend to improve the regulatory process in a way that does not weaken our commitment to environmental quality.

If there are better methods to achieve our environmental goals, we should use them. Agencies should seek and adopt innovative alternatives to government regulations which reduce burdens on private citizens or businesses. The Environmental Protection Agency has become a leader among federal agencies in examining new approaches and has made several moves to streamline its regulatory process. In addition to the permit consolidation, bubble concept, and offset policy mentioned above, EPA is doing an effective job of implementing my Executive order on regulatory reform and published the first agenda of regulations issued by any federal agency. A regulatory calendar is now prepared and published on a government-wide basis by the Regulatory Council I recently established.

Since 1977 the Occupational Health and Safety Administration has gotten rid of hundreds of unnecessary standards, and has reorganized its program to devote 95 percent of its resources to the most serious workplace hazards. In addition, regulatory agencies have begun to work together to coordinate their activities and use their resources more efficiently. I expect such progress to continue and I intend that it reinforce—not diminish—our environmental improvement efforts.

PENDING LEGISLATION AND REAUTHORIZATIONS

I have proposed and will continue to support reauthorization of important environmental statutes, including the Endangered Species Act, the Toxic Substances Control Act, the Safe Drinking Water Act, and the Resource Conservation and Recovery Act. I also continue to support a nongame wildlife program, and a wide range of wilderness proposals.

The Environmental Program I am outlining today expands upon the efforts we have already begun with a series of new initiatives in land and resource management, agricultural conservation, urban quality, and improving the global environment.

NEW INITIATIVES

LAND AND RESOURCE MANAGEMENT

America's land and natural resources have nourished our civilization. Because our original heritage was so abundant, we sometimes take these resources for granted. We can no longer do so. Our land and natural resources do have limits, and our demands upon them are growing at increasing rates. Renewable resources—farmlands, fisheries, and forests—can be depleted through overuse and misuse. We must build into our decisions the understanding that unwise actions affecting our lands and resources are difficult and costly, if not impossible, to correct.

Conservation of resources takes care and planning, and requires a partnership between various levels of government, and public and private actions. The following initiatives for protection and wise management of our coastal resources, public lands, wildlife and rivers and trails reflect this understanding.

National Coastal Protection

America's coast lines are extraordinarily varied, productive, and beautiful. Congress recognized the need for special protection in the Coastal Zone Man-

agement Act of 1972, which established a voluntary Federal-State partnership for the conservation and management of coastal resources. Under this partnership, many states have already made notable progress. They have passed comprehensive coastal management laws; adopted new measures to protect wetlands, barrier islands, mineral resources, historic sites, and other important coastal resources; worked out better management of hazardous areas; and streamlined Federal, State and local actions affecting the coast. By the end of 1979, 75 percent of the U.S. shoreline will be covered by Federally-approved state coastal zone management programs.

The coastal zone is subject to unusual pressures, both from natural causes and human activities. The land and water resources which support the environments and economies of coastal communities are in danger of depletion. The opportunity for our citizens to enjoy beaches, bays, and marshes is often threatened. I support efforts to improve our understanding of these coastal issues, and I heartily endorse the designation by conservation organizations of the year 1980 as the "Year of the Coast."

To help achieve the balanced, comprehensive and wise management intended by the Coastal Zone Management Act, I am announcing three initiatives to continue and improve our resource protection policy.

First, I will submit to Congress legislation to reauthorize federal assistance to state coastal zone management programs under the Coastal Zone Management Act. Under this extension, each state would be guaranteed a total of five years of federal assistance at current levels after a state management program is approved and before federal support is gradually phased down. This will help ensure that recently developed state and local coastal zone management efforts become fully established and accepted functions of government.

Second, I will recommend enactment of new amendments to the Coastal Zone Management Act that will establish a national coastal protection policy. Working through the states, the goals of this policy will be:

- to protect significant natural resources such as wetlands, estuaries, beaches, dunes, barrier islands, coral reefs, and fish and wildlife;
- to manage coastal development to minimize loss of life and property from floods, erosion, saltwater intrusion and subsidence;
- to provide predictable siting processes for major defense, energy, recreation and transportation facilities;
- to increase public access to the coast for recreation purposes;
- to preserve and restore historic, cultural and aesthetic coastal resources; and
- to coordinate and simplify government decisionmaking to ensure proper and expedited management of the coastal zone.

Third, I am directing the Secretary of Commerce to conduct a systematic review of federal programs that significantly affect coastal resources. This review, to be conducted by the National Oceanic and Atmospheric Administration, will provide the basis for specific recommendations to improve Federal actions affecting the coastal zone and to develop any additional legislation needed to achieve our national coastal management goals.

Public Land Resources

Among the many natural resource issues facing the Nation, few are more important than the management, protection and use of the 417 million acres of public lands owned by all Americans and administered by the Secretary of the Interior through the Bureau of Land Management.

The public lands include vast tracts of the arid rangelands of the West which were once lands that no one wanted. Now, some of these lands are highly valued for their energy and other valuable resources, and they have come to be appreciated for their scenic and natural values. My Administration is committed to purposeful management of the public lands and resources administered by the Bureau of Land Management in an environmentally sound and cost-effective manner.

Therefore, I am directing the Secretary of the Interior to manage the public lands administered by BLM in accordance with these principles:

- The Federal Government will be a good steward of the land, seeking to find the best balance of uses to assure that resources are available to meet the Nation's needs and that environmental values are carefully protected.
- The federal government will be a good neighbor, providing full opportunities for those affected by our management decisions to be involved in making them, with a special concern for the people and institutions of the Western States that are most directly affected.
- The federal government will make cost-effective investments in protecting and enhancing these lands within the constraints of fiscal responsibility.
- The federal government will seek to resolve conflicts among competing uses in a spirit of cooperation and trust, and will make—not avoid—tough decisions on the allocation of the valued resources of public lands.

We have already made significant progress in bringing these lands under effective management. A concerted federal effort is now underway to reverse the declining productivity of the 174 million acres of rangeland ecosystems managed by the Bureau of Land Management for livestock, wildlife, soil and moisture conservation, and other beneficial purposes. We have developed a comprehensive on-the-ground planning process for each unit of BLM-managed land which involves the public and assesses the environmental impacts of alternative actions. On June 4, 1979, the Secretary of the Interior announced our new federal coal management program, which establishes a balanced and efficient process for determining coal leasing and management on federal lands.

Much more remains to be done. I am therefore directing that the following actions be taken:

- The Secretary of the Interior will establish a comprehensive "program development process" for managing all the lands under BLM stewardship, which will, for the first time, set long range goals to ensure balanced protection and use of the resources and develop and analyze alternative programs and investment strategies to meet the goals. Each alternative program will be designed to achieve environmentally sound, fiscally responsible, and economically efficient investment, development, protection, and resource use. This new program planning process will supplement BLM's current unit-by-unit planning. It will invite state and local governments and interested citizens to participate in making better informed choices among the alternative programs.
- The Secretary will give special attention to protecting areas of BLM-administered lands with nationally significant wildlife, natural, scientific, cultural, or scenic resources. An example is the Birds of Prey area, located along the Snake River in the Idaho desert, that has North America's richest concentration of birds of prey, including dense nesting populations of falcons, eagles, and other raptors.
- Finally, I am directing the Secretary of the Interior and the Secretary of Agriculture to work together to coordinate their Departments' natural resource policies and programs, particularly those of the Bureau of Land Management and the Forest Service. I am requesting the two Secretaries to develop within six months a detailed statement of coordination objectives and a process and timetable for achieving them.

Wildlife Law Enforcement

A massive illegal trade in wild animals, wild animal parts and products, and wild plants has been uncovered in the last year through investigations by the Department of Justice, the Fish and Wildlife Service, the Customs Service and the Departments of Agriculture and Commerce.

This illegal trade in wildlife and plants has several very serious consequences. It can introduce exotic diseases, threatening agriculture. It creates a market for thousands of species of wildlife and plants taken in violation of

the laws of foreign nations, ultimately threatening the survival of these species. It is a danger to the survival of hundreds of species listed on the Convention on International Trade in Endangered Species, to which the United States is a signatory nation.

I am therefore submitting to Congress a bill to overcome obstacles inhibiting enforcement efforts.

In addition, I am directing the Departments of Agriculture, Commerce, Interior, Justice, and Treasury to investigate this trade aggressively and to prosecute violators of the law. I am directing the Department of the Interior to coordinate this effort, through an interagency Wildlife Law Enforcement Coordinating Committee which will review enforcement experiences, priorities and problems. I am also directing the Department of Agriculture to chair a task force to investigate the illegal trade in plants and to prosecute where appropriate.

I am further directing that the following specific steps be taken: The Treasury and Commerce Departments will raise the priority of wildlife enforcement cases; the Agriculture Department will place greater emphasis on coordinating its wildlife enforcement program with its disease quarantine program, and will begin hiring special agents to investigate the illegal plant trade; and the Department of Justice will establish a Wildlife Section which will be staffed principally by attorneys trained as wildlife law enforcement specialists.

Wild and Scenic Rivers

Our Nation's river corridors are a rich concentration of natural ecosystems, scenic beauty, and historic and recreational values. Since my Environmental Message of May 1977, eight rivers totalling 695 miles have been added to the National Wild and Scenic Rivers System, and nine new rivers have been recommended for study. As part of the Administration's Alaska proposals, 33 additional rivers have been proposed for National Wild and Scenic Rivers designation.

Development along the banks of our rivers continues to outpace our ability to protect those rivers that might qualify for designation. This problem is particularly acute near urban areas, where there are greater demands for recreational opportunities which can partly be met by river protection.

We need to speed up the process for studying Wild and Scenic Rivers for designation and to consider the protection of rivers or parts of rivers which can protect important natural ecosystems. Moreover, the Federal government should set an example of sound management for state, local, and private landowners by taking an aggressive role in protecting possible Wild and Scenic Rivers which flow through our public lands. Accordingly, I am directing the following actions be taken:

- federal land management agencies shall assess whether rivers located on their lands and identified in the National Inventory prepared by the Heritage Conservation and Recreation Service are suitable for inclusion in the Wild and Scenic Rivers System; if so, these agencies shall take prompt action to protect the rivers—either by preparing recommendations for their designation or by taking immediate action to protect them;
- all federal agencies shall avoid or mitigate adverse effects on rivers identified in the National Inventory; and
- the Secretary of Agriculture and the Secretary of the Interior shall jointly revise their Guidelines for evaluating wild, scenic, and recreational rivers to ensure consideration of river ecosystems and to shorten the time currently used to study rivers for designation.

In addition to the new policy initiatives, I am reaffirming my support for four river segments proposed in my last Environmental Message and recommending four new river segments which will add a total of 930 miles to the Wild and Scenic Rivers System:

- Gunnison River, Colorado (new)

- Encampment River, Colorado (new)
- Priest River, Idaho (new)
- Illinois River, Oregon (new)
- Bruneau River, Idaho (1977 Message)
- Dolores River, Colorado (1977 Message)
- Upper Mississippi River, Minnesota (1977 Message)
- Salmon River, Idaho (1977 Message).

I am also directing the Secretary of the Interior to develop, through the National Park Service and with full public participation, a conceptual master plan for the Upper Mississippi River in Minnesota. I expect this planning process to determine the specific requirements for protecting the river corridor and providing public access, campgrounds, and other recreational facilities on the lands now in private ownership. The conceptual master plan for this important national resource will be developed in cooperation with the Minnesota Department of Natural Resources, affected Indian tribes, and the public. It will be completed by April 1980.

In my last Environmental Message, I proposed 20 river segments for study as potential additions to the National Wild and Scenic Rivers System. Several of those rivers have already been designated. Except for rivers where subsequent development has affected the river's qualifications for designation, I will continue to seek study authorizations for these rivers. In addition, I am submitting legislation to add the North Umpqua River in Oregon to the list of those rivers to be studied.

I am also forwarding to Congress reports on several rivers which, after thorough study, were found to qualify for inclusion in the National System. However, because of the interest of the states or local governments in protecting their natural values, the reports recommend that the rivers be protected and managed by state and/or local action. I am greatly encouraged by the efforts which all levels of government are taking to protect valued natural resources. I am particularly pleased to note that in the case of the Housatonic and Shepaug Rivers in Connecticut, local governmental agencies are taking the lead in developing management plans to protect these significant river resources. I am transmitting reports on:

- Pine Creek, Pennsylvania
- Buffalo River, Tennessee
- Youghiogheny River, Pennsylvania-Maryland
- Shepaug River, Connecticut
- Kettle River, Minnesota
- Lower Wisconsin River, Wisconsin
- Housatonic River, Connecticut
- Illinois River, Oklahoma

National Trails

More than 61 million of the Nation's people go nature walking and more that 28 million people hike or backpack at least five times a year. To meet the growing needs of these and other trail users, Congress enacted the 1968 National Trails System Act and directed that a National Trails System be established. Since the establishment of the National Trails System, 257 National Recreation Trails have been designated, including 21 trails for those using wheelchairs and 13 trails designed for the use of blind people, with interpretive signs in braille.

The National Trails System is still in its fledgling stage and should grow to meet widespread public interest. National trails near urban areas can serve an energy-conscious nation by providing recreation close to home for the majority of our citizens and, in some cases, by providing commuter routes for bicyclists, walkers, and joggers.

To meet these objectives, under my direction, the U.S. Forest Service will establish 145 additional National Recreation Trails by January 1980, achieving a goal of two National Recreation Trails in each National Forest System

unit. I am directing each Federal land management agency to follow the example set by the Forest Service and by January 1980 announce a goal for the number of National Recreation Trails each agency will establish during 1980 on the public lands administered by the agency. I am also directing that, by the end of 1980, a minimum of 75 new National Recreation Trails shall be designated on public land other than National Forests by the federal land management agencies.

I am directing the Secretary of the Interior, through the Interagency Trails Council, to assist other Federal agencies in suverying existing trails on federal lands to determine which of those can be made part of our National Trails System and to initiate a grassroots effort in every region of the country to assess our nationwide trails needs. In addition, I am directing the Secretary of the Interior, the Secretary of Agriculture, the Secretary of Defense and the Chairman of the Tennessee Valley Authority to encourage states, localities, Indian tribes, and private landholders to designate trails on their lands.

Finally, I will submit legislation to the Congress which will designate the 513-mile Natchez Trace National Trail through Tennessee, Alabama and Mississippi. I will resubmit legislation to establish the Potomac Heritage Trail through Pennsylvania, Maryland, West Virginia, Virginia and Washington D.C. And I am reaffirming my support for the 3,200-mile North Country Trail, extending from the State of New York to North Dakota, which has already passed the House of Representatives.

I am also reaffirming the Administration's commitment to assuring the protection of the Appalachian Trail, one of America's best known and most popular recreation trails. The 2,000-mile Appalachian Trail winds through 14 states and is readily accessible to nearly half of the population of the U.S. It has been created by a volunteer movement without parallel in the history of outdoor recreation in America. In 1978 this Administration supported and I signed into law a bill to protect threatened portions of the right-of-way which are located on private lands. I expect this goal to be substantially achieved by September 30, 1981. This is a prompt but realistic timetable for the acquisition program.

AGRICULTURAL CONSERVATION

From our beginnings as a nation we have sustained ourselves and others on abundant yields from our farmlands. In this century, scientific and technological advances have increased our agricultural production to unsurpassed levels.

But in emphasizing ever-increasing production we have sometimes neglected to maintain the soil, water, and biological resources upon which the long-term stability and productivity of our agriculture depends. These resources are being degraded in many areas of the country. Our farm and land management practices have led to excessive soil erosion, we have overused chemical fertilizers and pesticides, and some of our most productive farmlands are being converted to nonagricultural uses. The agricultural conservation initiatives that I am announcing today address these issues.

Soil Conservation Incentives

Over the past half century we have invested more than $20 billion of federal funds in efforts to conserve soil. These funds have been used for cost sharing, technical assistance, resource management, loans, research, and education. Yet in that same half century wind and water erosion have removed half the fertile topsoil from nearly one-third of the Nation's potentially usable croplands. The cost of replacing just the plant nutrients lost to erosion has been estimated at $18 billion a year. Moreover, agricultural runoff adversely affects two-thirds of the Nation's streams.

Our soil protection programs have undoubtedly prevented even worse soil loss, but we must do better to maintain the long-term productivity of the soil.

The Department of Agriculture is now making an important appraisal of soil and water conservation policies under the Soil and Water Resources Conservation Act of 1977. The first Appraisal, Program and Policy reports required by the Resources Conservation Act (RCA) are due in January 1980. These documents will analyze conservation problems nationwide, set conservation targets, and propose ways to solve the problems. They will provide an essential first step in the wise management of agricultural lands, and will guide my Administration's overall soil and water conservation recommendations to the Congress. Reports will be updated every 5 years and I will receive annual reports of progress and program effectiveness.

I am directing the Secretary of Agriculture, in consultation with the Chairman of the Council on Environmental Quality, to build on the RCA process and to undertake a further detailed and systematic study of possible conservation incentives. The study will search for ways to modify or coordinate agricultural assistance programs already in existence in order to reduce soil erosion. Moreover, it will also look for conflicts or inconsistencies between farm income programs and soil conservation programs and will recommend measures to eliminate these conflicts where possible.

The results of this study will be submitted to me in January 1981. This report will provide me with specific administrative and legislative recommendations to reduce soil erosion and to improve soil stewardship in order to maintain the Nation's long-term agricultural productivity, building on the policy recommendations contained in the RCA 1980 program.

A second critical land issue for America's farmers and consumers is the availability of agricultural lands—particularly prime farmlands—and their conversion to other uses. In June, the Administration initiated an important new effort to address this issue. The Secretary of Agriculture and the Chairman of the Council on Environmental Quality are co-chairing an interagency study of factors affecting the availability of land for agricultural uses. The study will evaluate the economic, environmental, and social effects of the conversion or retention of agricultural lands and will make recommendations for consideration by federal, state, and local governments by January 1981.

Many members of Congress are particularly interested in these two critical issues affecting the stewardship of our nation's agricultural lands. I hope that the Administration and the Congress will work together to develop and implement appropriate actions, based on the results of these studies.

Integrated Pest Management

For all their benefits, chemical pesticides can cause unintended damage to human health and the environment. Many pests have developed resistance to chemical pesticides, escalating the cost of pest control by conventional methods. This resistence to pesticides has also decreased our ability to control some pests, which has reduced agricultural yields from what they would otherwise be.

Integrated pest management (IPM) has evolved in recent years as a comprehensive pest control strategy which has important health, economic, and environmental benefits. IPM uses a systems approach to reduce pest damage to tolerable levels through a variety of techniques, including natural predators and parasites, genetically resistant hosts, environmental modifications and, when necessary and appropriate, chemical pesticides. IPM strategies generally rely first upon biological defenses against pests before chemically altering the environment.

The Federal government—which spends more than $200 million a year on pest control research and implementation programs—should encourage the development and use of integrated pest management in agriculture, forestry, public and urban pest control. As a result of a governmentwide review initiated by my 1977 Environmental Message, I am now directing the appropriate federal agencies to modify as soon as possible their existing pest management research, control, education, and assistance programs and to support and adopt IPM strategies wherever practicable. I am also directing federal agen-

cies to report on actions taken or underway to implement IPM programs, and to coordinate their efforts through an interagency group.

URBAN QUALITY

Our cities give us diversity and enjoyment, occupations and avocations, shopping and services, recreation and culture. By strengthening the health of our urban environment, we broaden the range of opportunities open to all of our citizens, as I emphasized in my National Urban Policy Message last year. The investments we make in maintaining and improving urban quality—particularly those involving federal taxpayer dollars—can be designed to meet environmental objectives, such as safe, convenient, well-planned public transportation, quieter communities, and assistance in mediating potential conflicts between healthy urban economies and environments. The initiatives I am proposing today will help to achieve these goals.

Transportation Policy

Our transportation systems can greatly affect the nation's environment, for better or worse, especially in our cities. For many years, our energy and other resources were so plentiful that the federal government encouraged the rapid expansion of a transportation system based on the private automobile without fully considering the profound effects on our resources, our urban environments, and our way of life. Although we have developed an extraordinary transportation system, we have missed opportunities in the past to improve transportation and at the same time to achieve these other national health objectives.

The United States has built the most extensive and complex transportation system in the world. Federal transportation expenditures exceed $17 billion annually, including $12 billion in grants to state and local agencies. Transportation consumes approximately 53 percent of all petroleum used in the U.S. The energy and cost advantages of using this system more efficiently—for example, by greater use of carpools, vanpools and mass transit—are now obvious. Better design and use of transportation systems will also help to save and strengthen our cities and their amenities and to reduce air and noise pollution. Thus transportation decisions can help to conserve limited resources, and to further our energy, fiscal, and urban environmental goals.

Federal transportation decisions cannot escape difficult choices among competing objectives, but they must be guided by new transportation policies which I am establishing for my Administration. Urban transportation programs and projects should be reoriented to meet environmental, energy, and urban revitalization goals. I am therefore directing the Department to take immediate actions to assure that:

- federal transportation funds are used to promote energy conservation, for example through special lanes for carpools, vanpools, and transit vehicles;
- encouragement is given to using federal funds for public transportation projects;
- a careful review is made of any transportation proposal which would encourage urban sprawl (a major cause of high energy consumption) or which would tend to draw jobs away from urban centers;
- consideration is given to improving and rehabilitating existing facilities, or using non-construction methods—such as better traffic management—to improve transportation systems, as alternatives to constructing new facilities;
- major transportation projects are used to help improve the urban economy and to attract jobs to the urban cores;
- firm actions are taken to mitigate adverse effects of transportation projects on the natural and urban environment and to carry out the environmental commitments that are made in planning and approving transportation projects.

We have done a great deal to make our transportation policies and actions more sensitive to our national environmental and energy goals. We can do a great deal more with cooperation of state and local governments as our partners in the national transportation system. The steps I have outlined will move us in that direction.

Economic Assistance Program

Most Americans benefit directly from the healthier and more agreeable environment that results from our air, water, and other pollution control programs. Although economic data indicate that environmental programs are a strong positive factor in providing employment, there is continued concern about their possible adverse impact on individual firms, communities, or groups of workers. The fact that there have not been a large number of such economic dislocations does not suggest that those that do occur are unimportant. Furthermore, in some instances they can be avoided, or at least significantly mitigated, by appropriate government action.

In 1977 I established an Economic Assistance Task Force, chaired by the Council on Environmental Quality, to investigate whether we needed to improve federal assistance for those cases when jobs are lost partly as a result of actions taken to reduce pollution, and to recommend initiatives we might take. The Task Force concluded that existing federal assistance programs should be adequate, but that we need to take practical steps to let people know about the programs and to make sure help is delivered swiftly when it is needed.

I am therefore directing the Administrator of the Environmental Protection Agency to create an Economic Assistance Program in his agency and to designate Economic Assistance Officers both in headquarters and in the field, who will help the public understand and use the programs, and to make sure that eligible people receive assistance promptly. I am also directing all federal agencies with programs in this area to publicize and coordinate closely their programs. A booklet describing and locating available federal assistance programs will be released soon by the Council on Environmental Quality and the Environmental Protection Agency.

Urban Noise Program

A certain level of urban noise is tolerable or even agreeable, reflecting the multitude of activities that make a city thrive. However, most of our cities suffer from too much noise. Excessive noise is a serious disturbance in city dwellers' lives, and degrades the urban environment.

Most noise abatement actions are taken by state and local governments, but there is an important role for the Federal government. I am initiating today a program to reduce urban noise by directing the Departments of Commerce, Defense, Energy, Housing and Urban Development, Transportation, and the Environmental Protection Agency and General Services Administration, in consultation with other federal agencies, to take a number of actions to improve existing noise abatement programs, including:

- programs to achieve soundproofing and weatherization of noise sensitive buildings, such as schools and hospitals;
- use of quiet-design features in transportation projects affecting urban areas;
- measures to encourage the location of housing developments away from major noise sources;
- purchase of quiet equipment and products—such as typewriters and lawnmowers which have been designed to reduce noise—and assistance to state and local agencies to do likewise; and
- support for neighborhood efforts to deal with noise problems.

GLOBAL ENVIRONMENT

Efforts to improve the environment cannot be confined to our national boundaries. Ten years ago, at the dawn of the environmental decade, we

landed on the moon. For the first time people could stand on the surface of another world and look at the whole earth. The sight of earthrise was awesome. It was also sobering. From that moment we could no longer avoid understanding that all life must share this one small planet and its limited resources. The interdependence of nations is plain, and so is the responsibility of each to avoid actions which harm other nations or the world's environment. I am announcing today two initiatives which address global environmental problems of the greatest importance.

World Forests

The world's forests and woodlands are disappearing at alarming rates. Some estimates suggest that world forests could decline by about 20 percent by 2000. More than 40 percent of the closed forests of South Asia, Southeast Asia, Pacific, and Latin America could be lost.

Nearly all the world's forest loss is occurring in or near the tropics. In these areas, environmental damage from deforestation can be severe—even irreversible—and the human costs extremely high. For example, denudation of Himalayan slopes has led to severe soil erosion, silting of rivers, loss of groundwater, and intensified, catastrophic flooding downstream. Many tropical forests, once cut, will not regrow because soils, rainfall, temperature, or terrain are too unfavorable; nor will the land support crops or pasture for more than a few years. Another serious possible consequence of tropical forest loss is accelerating extinction of species. Tropical forests provide habitat for literally millions of plant and animal species—a genetic reservoir unmatched anywhere else in the world. Equally serious is the possibility that forest loss may adversely alter the global climate through production of carbon dioxide. These changes and their effects are not well understood and are being studied by scientists, but the possibilities are disturbing and warrant caution.

The United States and other nations are just beginning to appreciate fully the scope and seriousness of the problem and to assess the effects of development projects on world forests. There is much more to be done. I am therefore directing all relevant federal agencies to place greater emphasis on world forest issues in their budget and program planning. An interagency task force established last fall and chaired by the State Department will report to me in November 1979 on specific goals, strategies, and programs that the United States should undertake. On the basis of these recommendations, I will direct federal agencies to carry out an integrated set of actions to help toward protection and wise management of world forests.

In the international arena, the Governing Council of the United Nations Environment Programme has just adopted a resolution—introduced by the United States—calling for a meeting of experts to develop proposals for an integrated international program for conservation and wise utilization of tropical forests, and to report to the next Governing Council meeting in April 1980. I am asking the Departments of State and Agriculture, the Council on Environmental Quality, and other federal agencies to give this program full support and assistance and to encourage and support high-level multinational conferences on forest problems in regions where forest losses are severe.

To help protect the earth's natural resource base, I issued an Executive Order earlier this year, which directs federal agencies to review carefully in advance the effects of many federal activities abroad. I am directing the Council on Environmental Quality and the Department of State to report to me within six months on the best ways to designate the globally important resources to which the order applies.

Acid Rain

Acid rain has caused serious environmental damage in many parts of the world including Scandinavia, Northern Europe, Japan, Canada and the Northeastern part of the United States. Over the past 25 years the acidity of

rainfall has increased as much as fifty-fold in parts of the Eastern half of the United States. In the Adirondacks in New York, many mountain lakes have become devoid of fish partly because of increasing acidification. Adverse effects on crops and forests are suspected; steel and stone buildings and art works may suffer as well.

Acid rain is produced when rain removes sulfur dioxide and nitrogen dioxide from the air, forming sulfuric and nitric acid. Sulfur and nitrogen oxides are emitted in all forms of fossil fuel combustion. Power plants, smelters, steel mills, home furnaces, automobiles—all may contribute to acid rain.

To improve our understanding of acid rain, I am establishing a ten-year comprehensive Federal Acid Rain Assessment Program to be planned and managed by a standing Acid Rain Coordination Committee. The assessment program will include applied and basic research on acid rain effects, trends monitoring, transport and fate of pollutants, and control measures. The Committee will establish links with industry to promote cooperative research wherever appropriate. The Committee will also play a role in future research cooperation with Canada, Mexico, and other nations and internationa organizations. The Committee will prepare a comprehensive 10-year plan for review by the end of the year. In its first full year of operation, the program will have $10 million in reprogrammed research funds available, double the current amount for acid rain research.

It is important to emphasize that such a long-time acid rain research program will not delay application of necessary pollution control measures to meet the mandate of the Clean Air Act. In addition, interim results from the acid rain research program will be made available to the public, to states, to industry, and to the federal government agencies responsible for developing measures to reduce air pollution.

CONTINUED AND COOPERATIVE EFFORTS

The preservation of our environment has needed to become a special concern to our country at least since the ending of the Western frontier. A former President put it clearly:

> "The conservation of our natural resources and their proper use constitute the fundamental problem which underlies almost every other problem of our National life. We must maintain for our civilization the adequate material basis without which that civilization cannot exist. We must show foresight, we must look ahead. The reward of foresight of this nation is great and easily foretold. But there must be the look ahead, there must be a realization of the fact that to waste, to destroy, our natural resources, to skin and exhaust the land instead of using it so as to increase its usefulness, will result in undermining in the days of our children the very prosperity which we ought by right to hand down to them amplified and developed."

That was President Theodore Roosevelt speaking in a State of the Union Message more than 70 years ago.

That message needs to be repeated and heard just as clearly today. Above all—it needs to be delivered.

My Administration will continue to lead in conserving our resources and reducing risks to the environment through sound and efficient management. But all our citizens must join the effort by contributing energies and ideas.

Only with your cooperation can we maintain our advance toward protecting our environment. Only together can we hope to secure our world for the life to come.

Jimmy Carter

The White House,
August 2, 1979.

APPENDIX C

THE NATIONAL ENVIRONMENTAL POLICY ACT OF 1969, AS AMENDED*

An Act to establish a national policy for the environment, to provide for the establishment of a Council on Environmental Quality, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "National Environmental Policy Act of 1969."

PURPOSE

SEC. 2. The purposes of this Act are: To declare a national policy which will encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the Nation; and to establish a Council on Environmental Quality.

TITLE I

DECLARATION OF NATIONAL ENVIRONMENTAL POLICY

SEC. 101. (a) The Congress, recognizing the profound impact of man's activity on the interrelations of all components of the natural environment, particularly the profound influences of population growth, high-density urbanization, industrial expansion, resource exploitation, and new and expanding technological advances and recognizing further the critical importance of restoring and maintaining environmental quality to the overall welfare and development of man, declares that it is the continuing policy of the Federal Government, in cooperation with State and local governments, and other concerned public and private organizations, to use all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans.

(b) In order to carry out the policy set forth in this Act, it is the continuing responsibility of the Federal Government to use all practicable means, consistent with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs, and resources to the end that the Nation may—

(1) fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;

*Pub. L. 91–190, 42 U.S.C. 4321–4347, January 1, 1970, as amended by Pub. L. 94–52, July 3, 1975, and Pub. L. 94–83, August 9, 1975.

(2) assure for all Americans safe, healthful, productive, and esthetically and culturally pleasing surroundings;

(3) attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences;

(4) preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity, and variety of individual choice;

(5) achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities; and

(6) enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

(c) The Congress recognizes that each person should enjoy a healthful environment and that each person has a responsibility to contribute to the preservation and enhancement of the environment.

SEC. 102. The Congress authorizes and directs that, to the fullest extent possible: (1) the policies, regulations, and public laws of the United States shall be interpreted and administered in accordance with the policies set forth in this Act, and (2) all agencies of the Federal Government shall—

(a) Utilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences and the environmental design arts in planning and in decisionmaking which may have an impact on man's environment;

(b) Identify and develop methods and procedures, in consultation with the Council on Environmental Quality established by title II of this Act, which will insure that presently unquantified environmental amenities and values may be given appropriate consideration in decisionmaking along with economic and technical considerations;

(c) Include in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment, a detailed statement by the responsible official on—

(i) The environmental impact of the proposed action,

(ii) Any adverse environmental effects which cannot be avoided should the proposal be implemented,

(iii) Alternatives to the proposed action,

(iv) The relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and

(v) Any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

Prior to making any detailed statement, the responsible Federal official shall consult with and obtain the comments of any Federal agency which has jurisdiction by law or special expertise with respect to any environmental impact involved. Copies of such statement and the comments and views of the appropriate Federal, State, and local agencies, which are authorized to develop and enforce environmental standards, shall be made available to the President, the Council on Environmental Quality and to the public as provided by section 552 of title 5, United States Code, and shall accompany the proposal through the existing agency review processes;

(d) Any detailed statement required under subparagraph (c) after January 1, 1970, for any major Federal action funded under a program of grants to States shall not be deemed to be legally insufficient solely by reason of having been prepared by a State agency or official, if:

(i) the State agency or official has statewide jurisdiction and has the responsibility for such action,

(ii) the responsible Federal official furnishes guidance and participates in such preparation,

(iii) the responsible Federal official independently evaluates such statement prior to its approval and adoption, and

(iv) after January 1, 1976, the responsible Federal official provides early notification to, and solicits the views of, any other State or any Federal land management entity of any action or any alternative thereto which may have significant impacts upon such State or affected Federal land management entity and, if there is any disagreement on such impacts, prepares a written assessment of such impacts and views for incorporation into such detailed statement.

The procedures in this subparagraph shall not relieve the Federal official of his responsibilities for the scope, objectivity, and content of the entire statement or of any other responsibility under this Act; and further, this subparagraph does not affect the legal sufficiency of statements prepared by State agencies with less than statewide jurisdiction.

(e) Study, develop, and describe appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources;

(f) Recognize the worldwide and long-range character of environmental problems and, where consistent with the foreign policy of the United States, lend appropriate support to initiatives, resolutions, and programs designed to maximize international cooperation in anticipating and preventing a decline in the quality of mankind's world environment;

(g) Make available to States, counties, municipalities, institutions, and individuals, advice and information useful in restoring, maintaining, and enhancing the quality of the environment;

(h) Initiate and utilize ecological information in the planning and development of resource-oriented projects; and

(i) Assist the Council on Environmental Quality established by title II of this Act.

SEC. 103. All agencies of the Federal Government shall review their present statutory authority, administrative regulations, and current policies and procedures for the purpose of determining whether there are any deficiencies or inconsistencies therein which prohibit full compliance with the purposes and provisions of this Act and shall propose to the President not later than July 1, 1971, such measures as may be necessary to bring their authority and policies into conformity with the intent, purposes, and procedures set forth in this Act.

SEC. 104. Nothing in section 102 or 103 shall in any way affect the specific statutory obligations of any Federal agency (1) to comply with criteria or standards of environmental quality, (2) to coordinate or consult with any other Federal or State agency, or (3) to act, or refrain from acting contingent upon the recommendations or certification of any other Federal or State agency.

SEC. 105. The policies and goals set forth in this Act are supplementary to those set forth in existing authorizations of Federal agencies.

TITLE II

COUNCIL ON ENVIRONMENTAL QUALITY

SEC. 201. The President shall transmit to the Congress annually beginning July 1, 1970, an Environmental Quality Report (hereinafter referred to as the "report") which shall set forth (1) the status and condition of the major natural, manmade, or altered environmental classes of the Nation, including, but not limited to, the air, the aquatic, including marine, estuarine, and fresh water, and the terrestrial environment, including, but not limited to, the forest, dryland, wetland, range, urban, suburban and rural environment; (2) cur-

rent and foreseeable trends in the quality, management and utilization of such environments and the effects of those trends on the social, economic, and other requirements of the Nation; (3) the adequacy of available natural resources for fulfilling human and economic requirements of the Nation in the light of expected population pressures; (4) a review of the programs and activities (including regulatory activities) of the Federal Government, the State and local governments, and nongovernmental entities or individuals with particular reference to their effect on the environment and on the conservation, development and utilization of natural resources; and (5) a program for remedying the deficiencies of existing programs and activities, together with recommendations for legislation.

SEC. 202. There is created in the Executive Office of the President a Council on Environmental Quality (hereinafter referred to as the "Council"). The Council shall be composed of three members who shall be appointed by the President to serve at his pleasure, by and with the advice and consent of the Senate. The President shall designate one of the members of the Council to serve as Chairman. Each member shall be a person who, as a result of his training, experience, and attainments, is exceptionally well qualified to analyze and interpret environmental trends and information of all kinds; to appraise programs and activities of the Federal Government in the light of the policy set forth in title I of this Act; to be conscious of and responsive to the scientific, economic, social, esthetic, and cultural needs and interests of the Nation; and to formulate and recommend national policies to promote the improvement of the quality of the environment.

SEC. 203. The Council may employ such officers and employees as may be necessary to carry out its functions under this Act. In addition, the Council may employ and fix the compensation of such experts and consultants as may be necessary for the carrying out of its functions under this Act, in accordance with section 3109 of title 5, United States Code (but without regard to the last sentence thereof).

SEC. 204. It shall be the duty and function of the Council—

(1) to assist and advise the President in the preparation of the Environmental Quality Report required by section 201 of this title;

(2) to gather timely and authoritative information concerning the conditions and trends in the quality of the environment both current and prospective, to analyze and interpret such information for the purpose of determining whether such conditions and trends are interfering, or are likely to interfere, with the achievement of the policy set forth in title I of this Act, and to compile and submit to the President studies relating to such conditions and trends;

(3) to review and appraise the various programs and activities of the Federal Government in the light of the policy set forth in title I of this Act for the purpose of determining the extent to which such programs and activities are contributing to the achievement of such policy, and to make recommendations to the President with respect thereto;

(4) to develop and recommend to the President national policies to foster and promote the improvement of environmental quality to meet the conservation, social, economic, health, and other requirements and goals of the Nation;

(5) to conduct investigations, studies, surveys, research, and analyses relating to ecological systems and environmental quality;

(6) to document and define changes in the natural environment, including the plant and animal systems, and to accumulate necessary data and other information for a continuing analysis of these changes or trends and an interpretation of their underlying causes;

(7) to report at least once each year to the President on the state and condition of the environment; and

(8) to make and furnish such studies, reports thereon, and recommendations with respect to matters of policy and legislation as the President may request.

SEC. 205. In exercising its powers, functions, and duties under this Act, the Council shall—

(1) Consult with the Citizens' Advisory Committee on Environmental Quality established by Executive Order No. 11472, dated May 29, 1969, and with such representatives of science, industry, agriculture, labor, conservation organizations, State and local governments and other groups, as it deems advisable; and

(2) Utilize, to the fullest extent possible, the services, facilities and information (including statistical information) of public and private agencies and organizations, and individuals, in order that duplication of effort and expense may be avoided, thus assuring that the Council's activities will not unnecessarily overlap or conflict with similar activities authorized by law and performed by established agencies.

SEC. 206. Members of the Council shall serve full time and the Chairman of the Council shall be compensated at the rate provided for Level II of the Executive Schedule Pay Rates (5 U.S.C. 5313). The other members of the Council shall be compensated at the rate provided for Level IV of the Executive Schedule Pay Rates (5 U.S.C. 5315).

SEC. 207. The Council may accept reimbursements from any private nonprofit organization or from any department, agency, or instrumentality of the Federal Government, any State, or local government, for the reasonable travel expenses incurred by an officer or employee of the Council in connection with his attendance at any conference, seminar, or similar meeting conducted for the benefit of the Council.

SEC. 208. The Council may make expenditures in support of its international activities, including expenditures for: (1) international travel; (2) activities in implementation of international agreements; and (3) the support of international exchange programs in the United States and in foreign countries.

SEC. 209. There are authorized to be appropriated to carry out the provisions of this chapter not to exceed $300,000 for fiscal year 1970, $700,000 for fiscal year 1971, and $1,000,000 for each fiscal year thereafter.

APPENDIX D

THE ENVIRONMENTAL QUALITY IMPROVEMENT ACT OF 1970*

TITLE II—ENVIRONMENTAL QUALITY (OF THE WATER QUALITY IMPROVEMENT ACT OF 1974)

SHORT TITLE

SEC. 201. This title may be cited as the "Environmental Quality Improvement Act of 1970."

FINDINGS, DECLARATIONS, AND PURPOSES

SEC. 202. (a) The Congress finds—

(1) That man has caused changes in the environment;

(2) That many of these changes may affect the relationship between man and his environment; and

(3) The population increases and urban concentration contribute directly to pollution and the degradation of our environment.

(b)(1) The Congress declares that there is a national policy for the environment which provides for the enhancement of environmental quality. This policy is evidenced by statutes heretofore enacted relating to the prevention, abatement, and control of environmental pollution, water and land resources, transportation, and economic and regional development.

(2) The primary responsibility for implementing this policy rests with State and local governments.

(3) The Federal Government encourages and supports implementation of this policy through appropriate regional organizations established under existing law.

(c) The purposes of this title are—

(1) To assure that each Federal department and agency conducting or supporting public works activities which affect the environment shall implement the policies established under existing law; and

(2) To authorize an Office of Environmental Quality, which, notwithstanding any other provision of law, shall provide the professional and administrative staff for the Council on Environmental Quality established by Public Law 91–190.

OFFICE OF ENVIRONMENTAL QUALITY

SEC. 203. (a) There is established in the Executive Office of the President an office to be known as the Office of Environmental Quality (hereafter in this

*Pub. L. 91–224, 42 U.S.C. 4371–4374, April 3, 1970.

title referred to as the "Office"). The Chairman of the Council on Environmental Quality established by Public Law 91–190 shall be the Director of the Office. There shall be in the Office a Deputy Director who shall be appointed by the President, by and with the advice and consent of the Senate.

(b) The compensation of the Deputy Director shall be fixed by the President at a rate not in excess of the annual rate of compensation payable to the Deputy Director of the Bureau of the Budget.

(c) The Director is authorized to employ such officers and employees (including experts and consultants) as may be necessary to enable the Office to carry out its functions under this title and Public Law 91–190, except that he may employ no more than 10 specialists and other experts without regard to the provisions of title 5, United States Code, governing appointments in the competitive service, and pay such specialists and experts without regard to the provisions of chapter 51 and subchapter 111 of chapter 53 of such title relating to classification and General Schedule pay rates, but no such specialist or expert shall be paid at a rate in excess of the maximum rate for GS–18 of the General Schedule under section 5330 of title 5.

(d) In carrying out his functions the Director shall assist and advise the President on policies and programs of the Federal Government affecting environmental quality by—

(1) Providing the professional and administrative staff and support for the Council on Environmental Quality established by Public Law 91–190;

(2) Assisting the Federal agencies and departments in appraising the effectiveness of existing and proposed facilities, programs, policies, and activities of the Federal Government, and those specific major projects designated by the President which do not require individual project authorization by Congress, which affect environmental quality;

(3) Reviewing the adequacy of existing systems for monitoring and predicting environmental changes in order to achieve effective coverage and efficient use of research facilities and other resources;

(4) Promoting the advancement of scientific knowledge of the effects of actions and technology on the environment and encourage the development of the means to prevent or reduce adverse effects that endanger the health and well-being of man;

(5) Assisting in coordinating among the Federal departments and agencies those programs and activities which affect, protect, and improve environmental quality;

(6) Assisting the Federal departments and agencies in the development and interrelationship of environmental quality criteria and standards established through the Federal Government;

(7) Collecting, collating, analyzing, and interpreting data and information on environmental quality, ecological research, and evaluation.

(e) The Director is authorized to contract with public or private agencies, institutions, and organizations and with individuals without regard to sections 3618 and 3709 of the Revised Statutes (31 U.S.C. 529; 41 U.S.C. 5) in carrying out his functions.

REPORT

SEC. 204. Each Environmental Quality Report required by Public Law 91–190 shall, upon transmittal to Congress, be referred to each standing committee having jurisdiction over any part of the subject matter of the Report.

AUTHORIZATION

SEC. 205. There are hereby authorized to be appropriated not to exceed $500,000 for fiscal year ending June 30, 1970, not to exceed $750,000 for the fiscal year ending June 30, 1971, not to exceed $1,250,000 for the fiscal year

ending June 30, 1972, and not to exceed $1,500,000 for the fiscal year ending June 30, 1973. These authorizations are in addition to those contained in Public Law 91–190.

Approved April 3, 1970.

APPENDIX E

EXECUTIVE ORDER 11514, AS AMENDED BY EXECUTIVE ORDER 11991 (SECS. 2(g) AND 3(h)), MAY 24, 1977, PROTECTION AND ENHANCEMENT OF ENVIRONMENTAL QUALITY

By virtue of the authority vested in me as President of the United States and in furtherance of the purpose and policy of the National Environmental Policy Act of 1969 (Public Law No. 91–190, approved January 1, 1970), it is ordered as follows:

Section 1. *Policy.* The Federal Government shall provide leadership in protecting and enhancing the quality of the Nation's environment to sustain and enrich human life. Federal agencies shall initiate measures needed to direct their policies, plans and programs so as to meet national environmental goals. The Council on Environmental Quality, through the Chairman, shall advise and assist the President in leading this national effort.

Sec. 2. *Responsibilities of Federal agencies.* Consonant with Title I of the National Environmental Policy Act of 1969, hereafter referred to as the "Act", the heads of Federal agencies shall:

(a) Monitor, evaluate, and control on a continuing basis their agencies' activities so as to protect and enhance the quality of the environment. Such activities shall include those directed to controlling pollution and enhancing the environment and those designed to accomplish other program objectives which may affect the quality of the environment. Agencies shall develop programs and measures to protect and enhance environmental quality and shall assess progress in meeting the specific objectives of such activities. Heads of agencies shall consult with appropriate Federal, State and local agencies in carying out their activities as they affect the quality of the environment.

(b) Develop procedures to insure the fullest practicable provision of timely public information and understanding of Federal plans and programs with environmental impact in order to obtain the views of interested parties. These procedures shall include, whenever appropriate, provision for public hearings, and shall provide the public with relevant information, including information on alternative courses of action. Federal agencies shall also encourage State and local agencies to adopt similar procedures for informing the public concerning their activities affecting the quality of the environment.

(c) Insure that information regarding existing or potential environmental problems and control methods developed as part of research, development, demonstration, test, or evaluation activities is made available to Federal agencies, States, counties, municipalities, institutions, and other entities, as appropriate.

(d) Review their agencies' statutory authority, administrative regulations, policies, and procedures, including those relating to loans, grants,

contracts, leases, licenses, or permits, in order to identify any deficiencies or inconsistencies therein which prohibit or limit full compliance with the purposes and provisions of the Act. A report on this review and the corrective actions taken or planned, including such measures to be proposed to the President as may be necessary to bring their authority and policies into conformance with the intent, purposes, and procedures of the Act, shall be provided to the Council on Environmental Quality not later than September 1, 1970.

(e) Engage in exchange of data and research results, and cooperate with agencies of other governments to foster the purposes of the Act.

(f) Proceed, in coordination with other agencies, with actions required by section 102 of the Act.

(g) In carrying out their responsibilities under the Act and this Order, comply with the regulations issued by the Council except where such compliance would be inconsistent with statutory requirements.

Section 3. *Responsibilities of Council on Environmental Quality.* The Council on Environmental Quality shall:

(a) Evaluate existing and proposed policies and activities of the Federal Government directed to the control of pollution and the enhancement of the environment and to the accomplishment of other objectives which affect the quality of the environment. This shall include continuing review of procedures employed in the development and enforcement of Federal standards affecting environmental quality. Based upon such evaluations the Council shall, where appropriate, recommend to the President policies and programs to achieve more effective protection and enhancement of environmental quality and shall, where appropriate, seek resolution of significant environmental issues.

(b) Recommend to the President and to the agencies priorities among programs designed for the control of pollution and for enhancement of the environment.

(c) Determine the need for new policies and programs for dealing with environmental problems not being adequately addressed.

(d) Conduct, as it determines to be appropriate, public hearings or conferences on issues of environmental significance.

(e) Promote the development and use of indices and monitoring systems (1) to assess environmental conditions and trends, (2) to predict the environmental impact of proposed public and private actions, and (3) to determine the effectiveness of programs for protecting and enhancing environmental quality.

(f) Coordinate Federal programs related to environmental quality.

(g) Advise and assist the President and the agencies in achieving international cooperation for dealing with environmental problems, under the foreign policy guidance of the Secretary of State.

(h) Issue regulations to Federal agencies for the implementation of the procedural provisions of the Act (42 U.S.C. 4332(2)). Such regulations shall be developed after consultation with affected agencies and after such public hearings as may be appropriate. They will be designed to make the environmental impact statement process more useful to decisionmakers and the public; and to reduce paperwork and the accumulation of extraneous background data, in order to emphasize the need to focus on real environmental issues and alternatives. They will require impact statements to be concise, clear, and to the point, and supported by evidence that agencies have made the necessary environmental analyses. The Council shall include in its regulations procedures (1) for the early preparation of environmental impact statements, and (2) for the referral to the Council of conflicts between agencies concerning the implementation of the National Environmental Policy Act of 1969, as amended, and Section 309 of the Clean Air Act, as amended, for the Council's recommendation as to their prompt resolution.

(i) Issue such other instructions to agencies, and request such reports and other information from them, as may be required to carry out the Council's responsibilities under the Act.

(j) Assist the President in preparing the annual Environmental Quality Report provided for in section 201 of the Act.

(k) Foster investigations, studies, surveys, research, and analyses relating to (i) ecological systems and environmental quality, (ii) the impact of new and changing technologies thereon, and (iii) means of preventing or reducing adverse effects from such technologies.

Section 4. *Amendments of E.O. 11472.* Executive Order No. 11472 of May 29, 1969, including the heading thereof, is hereby amended:

(1) By substituting for the term "the Environmental Quality Council", wherever it occurs, the following: "the Cabinet Committee on the Environment".

(2) By substituting for the term "the Council", wherever it occurs, the following: "the Cabinet Committee".

(3) By inserting in subsection (f) of section 101, after "Budget,", the following: "the Director of the Office of Science and Technology,".

(4) By substituting for subsection (g) of section 101 the following:

"(g) The Chairman of the Council on Environmental Quality (established by Public Law 91–190) shall assist the President in directing the affairs of the Cabinet Committee."

(5) By deleting subsection (c) of section 102.

(6) By substituting for "the Office of Science and Technology", in section 104, the following: "the Council on Environmental Quality (established by Public Law 91–190)".

(7) By substituting for "(hereinafter referred to as the 'Committee')", in section 201, the following: "(hereinafter referred to as the 'Citizens' Committee')".

(8) By substituting for the term "the Committee", wherever it occurs, the following: "the Citizens' Committee".

APPENDIX F

REGULATIONS FOR IMPLEMENTING THE PROCEDURAL PROVISIONS OF NEPA

The Council on Environmental Quality is responsible for overseeing Federal efforts to comply with the National Environmental Policy Act (NEPA). In 1970, the Council issued guidelines for the preparation of environmental impact statements (EISs) under Executive Order 11514 (1970). By the terms of the Executive Order, the Guidelines were confined to Subsection (C) of Section 102(2) of NEPA—the requirement for environmental impact statements.

On May 24, 1977, President Carter issued Executive Order 11991 directing the Council to issue regulations to replace the Guidelines for preparation of EISs and to implement other provisions for agency planning and decision-making contained in Section 102(2) of the Act. These new regulations, 40 CFR Parts 1500–1508, reprinted below, were promulgated on November 29, 1978 and became effective July 30, 1979.

The new regulations have three principal aims: to reduce paperwork, to reduce delays, and to produce better decisions.

In accordance with the President's directive, the Council's regulations are binding on all Federal agencies, replace some 70 different sets of agency regulations, and provide uniform standards applicable throughout the Federal government for conducting environmental reviews. The regulations also establish formal guidance from the Council on the requirements of NEPA for use by the courts in interpreting this law.

PART 1500—PURPOSE, POLICY, AND MANDATE

1500.1 Purpose
1500.2 Policy
1500.3 Mandate
1500.4 Reducing paperwork
1500.5 Reducing delay
1500.6 Agency authority

AUTHORITY: NEPA, the Environmental Quality Improvement Act of 1970, as amended (42 U.S.C. 4371 et seq.), section 309 of the Clean Air Act, as amended (42 U.S.C. 7609) and Executive Order 11514, Protection and Enhancement of Environmental Quality (March 5, 1970 as amended by Executive Order 11991, May 24, 1977).

§ 1500.1 PURPOSE

(a) The National Environmental Policy Act (NEPA) is our basic national charter for protection of the environment. It establishes policy, sets goals (section 101), and provides means (section 102) for carrying out the policy.

Section 102(2) contains "action-forcing" provisions to make sure that federal agencies act according to the letter and spirit of the Act. The regulations that follow implement Section 102(2). Their purpose is to tell federal agencies what they must do to comply with the procedures and achieve the goals of the Act. The President, the federal agencies, and the courts share responsibility for enforcing the Act so as to achieve the substantive requirements of section 101.

(b) NEPA procedures must insure that environmental information is available to public officials and citizens before decisions are made and before actions are taken. The information must be of high quality. Accurate scientific analysis, expert agency comments, and public scrutiny are essential to implementing NEPA. Most important, NEPA documents must concentrate on the issues that are truly significant to the action in question, rather than amassing needless detail.

(c) Ultimately, of course, it is not better documents but better decisions that count. NEPA's purpose is not to generate paperwork—even excellent paperwork—but to foster excellent action. The NEPA process is intended to help public officials make decisions that are based on understanding of environmental consequences, and take actions that protect, restore, and enhance the environment. These regulations provide the direction to achieve this purpose.

§ 1500.2 POLICY

Federal agencies shall to the fullest extent possible:

(a) Interpret and administer the policies, regulations, and public laws of the United States in accordance with the policies set forth in the Act and in these regulations.

(b) Implement procedures to make the NEPA process more useful to decisionmakers and the public; to reduce paperwork and the accumulation of extraneous background data; and to emphasize real environmental issues and alternatives. Environmental impact statements shall be concise, clear, and to the point, and shall be supported by evidence that agencies have made the necessary environmental analyses.

(c) Integrate the requirements of NEPA with other planning and environmental review procedures required by law or by agency practice so that all such procedures run concurrently rather than consecutively.

(d) Encourage and facilitate public involvement in decisions which affect the quality of the human environment.

(e) Use the NEPA process to identify and assess the reasonable alternatives to proposed actions that will avoid or minimize adverse effects of these actions upon the quality of the human environment.

(f) Use all practicable means, consistent with the requirements of the Act and other essential considerations of national policy, to restore and enhance the quality of the human environment and avoid or minimize any possible adverse effects of their actions upon the quality of the human environment.

§ 1500.3 MANDATE

Parts 1500–1508 of this Title provide regulations applicable to and binding on all Federal agencies for implementing the procedural provisions of the National Environmental Policy Act of 1969, as amended (Pub. L. 91–190, 42 U.S.C. 4321 et seq.) (NEPA or the Act) except where compliance would be inconsistent with other statutory requirements. These regulations are issued pursuant to NEPA, the Environmental Quality Improvement Act of 1970, as amended (42 U.S.C. 4371 et seq.) Section 309 of the Clean Air Act, as amended (42 U.S.C. 7609) and Executive Order 11514, Protection and Enhancement of Environmental Quality (March 5, 1970, as amended by

Executive Order 11991, May 24, 1977). These regulations, unlike the predecessor guidelines, are not confined to Sec. 102(2)(C) (environmental impact statements). The regulations apply to the whole of section 102(2). The provisions of the Act and of these regulations must be read together as a whole in order to comply with the spirit and letter of the law. It is the Council's intention that judicial review of agency compliance with these regulations not occur before an agency has filed the final environmental impact statement, or has made a final finding of no significant impact (when such a finding will result in action affecting the environment), or takes action that will result in irreparable injury. Furthermore, it is the Council's intention that any trivial violation of these regulations not give rise to any independent cause of action.

§ 1500.4 REDUCING PAPERWORK

Agencies shall reduce excessive paperwork by:

(a) Reducing the length of environmental impact statements (§ 1502.2(c)), by means such as setting appropriate page limits (§§ 1501.7(b)(1) and 1502.7).

(b) Preparing analytic rather than encyclopedic environmental impact statements (§ 1502.2(a)).

(c) Discussing only briefly issues other than significant ones (§ 1502.2(b)).

(d) Writing environmental impact statements in plain language (§ 1502.8).

(e) Following a clear format for environmental impact statements (§ 1502.10).

(f) Emphasizing the portions of the environmental impact statement that are useful to decisionmakers and the public (§§ 1502.14 and 1502.15) and reducing emphasis on background material (§ 1502.16).

(g) Using the scoping process, not only to identify significant environmental issues deserving of study, but also to deemphasize insignificant issues, narrowing the scope of the environmental impact statement process accordingly (§ 1501.7).

(h) Summarizing the environmental impact statement (§ 1502.12) and circulating the summary instead of the entire environmental impact statement if the latter is unusually long (§ 1502.19).

(i) Using program, policy, or plan environmental impact statements and tiering from statements of broad scope to those of narrower scope, to eliminate repetitive discussions of the same issues (§§ 1502.4 and 1502.20).

(j) Incorporating by reference (§ 1502.21).

(k) Integrating NEPA requirements with other environmental review and consultation requirements (§ 1502.25).

(l) Requiring comments to be as specific as possible (§ 1503.3).

(m) Attaching and circulating only changes to the draft environmental impact statement, rather than rewriting and circulating the entire statement when changes are minor (§ 1503.4(c)).

(n) Eliminating duplication with State and local procedures, by providing for joint preparation (§ 1506.2), and with other Federal procedures, by providing that an agency may adopt appropriate environmental documents prepared by another agency (§ 1506.3).

(o) Combining environmental documents with other documents (§ 1506.4).

(p) Using categorical exclusions to define categories of actions which do not individually or cumulatively have a significant effect on the human environment and which are therefore exempt from requirements to prepare an environmental impact statement (§ 1508.4).

(q) Using a finding of no significant impact when an action not otherwise excluded will not have a significant effect on the human environment and is therefore exempt from requirements to prepare an environmental impact statement (§ 1508.13).

§ 1500.5 REDUCING DELAY

Agencies shall reduce delay by:

(a) Integrating the NEPA process into early planning (§ 1501.2).

(b) Emphasizing interagency cooperation before the environmental impact statement is prepared, rather than submission of adversary comments on a completed document (§ 1501.6).

(c) Insuring the swift and fair resolution of lead agency disputes (§ 1501.5).

(d) Using the scoping process for an early identification of what are and what are not the real issues (§ 1501.7).

(e) Establishing appropriate time limits for the environmental impact statement process (§§ 1501.7(b)(2) and 1501.8).

(f) Preparing environmental impact statements early in the process (§ 1502.5).

(g) Integrating NEPA requirements with other environmental review and consultation requirements (§ 1502.25).

(h) Eliminating duplication with State and local procedures by providing for joint preparation (§ 1506.2) and with other Federal procedures by providing that an agency may adopt appropriate environmental documents prepared by another agency (§ 1506.3).

(i) Combining environmental documents with other documents (§ 1506.4).

(j) Using accelerated procedures for proposals for legislation (§ 1506.8).

(k) Using categorical exclusions to define categories of actions which do not individually or cumulatively have a significant effect on the human environment (§ 1508.4) and which are therefore exempt from requirements to prepare an environmental impact statement.

(l) Using a finding of no significant impact when an action not otherwise excluded will not have a significant effect on the human environment (§ 1508.13) and is therefore exempt from requirements to prepare an environmental impact statement.

§ 1500.6 AGENCY AUTHORITY

Each agency shall interpret the provisions of the Act as a supplement to its existing authority and as a mandate to view traditional policies and missions in the light of the Act's national environmental objectives. Agencies shall review their policies, procedures, and regulations accordingly and revise them as necessary to insure full compliance with the purposes and provisions of the Act. The phrase "to the fullest extent possible" in section 102 means that each agency of the Federal Government shall comply with that section unless existing law applicable to the agency's operations expressly prohibits or makes compliance impossible.

PART 1501—NEPA AND AGENCY PLANNING

1501.1 Purpose
1501.2 Apply NEPA early in the process
1501.3 When to prepare an environmental assessment
1501.4 Whether to prepare an environmental impact statement
1501.5 Lead agencies
1501.6 Cooperating agencies
1501.7 Scoping
1501.8 Time limits

AUTHORITY: NEPA, the Environmental Quality Improvement Act of 1970, as amended (42 U.S.C. 4371 et seq.), Section 309 of the Clean Air Act, as amended (42 U.S.C. 7609), and Executive Order 11514, Protection and En-

hancement of Environmental Quality (March 5, 1970, as amended by Executive Order 11991, May 24, 1977).

§ 1501.1 PURPOSE

The purposes of this part include:

(a) Integrating the NEPA process into early planning to insure appropriate consideration of NEPA's policies and to eliminate delay.

(b) Emphasizing cooperative consultation among agencies before the environmental impact statement is prepared rather than submission of adversary comments on a completed document.

(c) Providing for the swift and fair resolution of lead agency disputes.

(d) Identifying at an early stage the significant environmental issues deserving of study and deemphasizing insignificant issues, narrowing the scope of the environmental impact statement accordingly.

(e) Providing a mechanism for putting appropriate time limits on the environmental impact statement process.

§ 1501.2 APPLY NEPA EARLY IN THE PROCESS

Agencies shall integrate the NEPA process with other planning at the earliest possible time to insure that planning and decisions reflect environmental values, to avoid delays later in the process, and to head off potential conflicts. Each agency shall:

(a) Comply with the mandate of section 102(2)(A) to "utilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences and the environmental design arts in planning and in decisionmaking which may have an impact on man's environment," as specified by § 1507.2.

(b) Identify environmental effects and values in adequate detail so they can be compared to economic and technical analyses. Environmental documents and appropriate analyses shall be circulated and reviewed at the same time as other planning documents.

(c) Study, develop, and describe appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources as provided by section 102(2)(E) of the Act.

(d) Provide for cases where actions are planned by private applicants or other non-Federal entities before Federal involvement so that:

(1) Policies or designated staff are available to advise potential applicants of studies or other information foreseeably required for later Federal action.

(2) The Federal agency consults early with appropriate State and local agencies and Indian tribes and with interested private persons and organizations when its own involvement is reasonably foreseeable.

(3) The Federal agency commences its NEPA process at the earliest possible time.

§ 1501.3 WHEN TO PREPARE AN ENVIRONMENTAL ASSESSMENT

(a) Agencies shall prepare an environmental assessment (§ 1508.9) when necessary under the procedures adopted by individual agencies to supplement these regulations as described in § 1507.3. An assessment is not necessary if the agency has decided to prepare an environmental impact statement.

(b) Agencies may prepare an environmental assessment on any action at any time in order to assist agency planning and decisionmaking.

§ 1501.4 WHETHER TO PREPARE AN ENVIRONMENTAL IMPACT STATEMENT

In determining whether to prepare an environmental impact statement the Federal agency shall:

(a) Determine under its procedures supplementing these regulations (described in § 1507.3) whether the proposal is one which:

(1) Normally requires an environmental impact statement, or

(2) Normally does not require either an environmental impact statement or an environmental assessment (categorical exclusion).

(b) If the proposed action is not covered by paragraph (a) of this section, prepare an environmental assessment (§ 1508.9). The agency shall involve environmental agencies, applicants, and the public, to the extent practicable, in preparing assessments required by § 1508.9(a)(1).

(c) Based on the environmental assessment make its determination whether to prepare an environmental impact statement.

(d) Commence the scoping process (§ 1501.7), if the agency will prepare an environmental impact statement.

(e) Prepare a finding of no significant impact (§ 1508.13), if the agency determines on the basis of the environmental assessment not to prepare a statement.

(1) The agency shall make the finding of no significant impact available to the affected public as specified in § 1506.6.

(2) In certain limited circumstances, which the agency may cover in its procedures under § 1507.3, the agency shall make the finding of no its procedures under § 1507.3, the agency shall make the finding of no significant impact available for public review (including State and area-wide clearinghouses) for 30 days before the agency makes its final determination whether to prepare an environmental impact statement and before the action may begin. The circumstances are:

(i) The proposed action is, or is closely similar to, one which normally requires the preparation of an environmental impact statement under the procedures adopted by the agency pursuant to § 1507.3, or

(ii) The nature of the proposed action is one without precedent.

§ 1501.5 LEAD AGENCIES

(a) A lead agency shall supervise the preparation of an environmental impact statement if more than one Federal agency either:

(1) Proposes or is involved in the same action; or

(2) Is involved in a group of actions directly related to each other because of their functional interdependence or geographical proximity.

(b) Federal, State, or local agencies, including at least one Federal agency, may act as joint lead agencies to prepare an environmental impact statement (§ 1506.2).

(c) If an action falls within the provisions of paragraph (a) of this section the potential lead agencies shall determine by letter or memorandum which agency shall be the lead agency and which shall be cooperating agencies. The agencies shall resolve the lead agency question so as not to cause delay. If there is disagreement among the agencies, the following factors (which are listed in order of descending importance) shall determine lead agency designation:

(1) Magnitude of agency's involvement.
(2) Project approval/disapproval authority.
(3) Expertise concerning the action's environmental effects.
(4) Duration of agency's involvement.
(5) Sequence of agency's involvement.

(d) Any Federal agency, or any State or local agency or private person substantially affected by the absence of lead agency designation, may make a written request to the potential lead agencies that a lead agency be designated.

(e) If Federal agencies are unable to agree on which agency will be the lead agency or if the procedure described in paragraph (c) of this section

has not resulted within 45 days in a lead agency designation, any of the agencies or persons concerned may file a request with the Council asking it to determine which Federal agency shall be the lead agency.

A copy of the request shall be transmitted to each potential lead agency. The request shall consist of:

(1) A precise description of the nature and extent of the proposed action.

(2) A detailed statement of why each potential lead agency should or should not be the lead agency under the criteria specified in paragraph (c) of this section.

(f) A response may be filed by any potential lead agency concerned within 20 days after a request is filed with the Council. The Council shall determine as soon as possible but not later than 20 days after receiving the request and all responses to it which Federal agency shall be the lead agency and which other Federal agencies shall be cooperating agencies.

§ 1501.6 COOPERATING AGENCIES

The purpose of this section is to emphasize agency cooperation early in the NEPA process. Upon request of the lead agency, any other Federal agency which has jurisdiction by law shall be a cooperating agency. In addition any other Federal agency which has special expertise with respect to any environmental issue, which should be addressed in the statement may be a cooperating agency upon request of the lead agency. An agency may request the lead agency to designate it a cooperating agency.

(a) The lead agency shall:

(1) Request the participation of each cooperating agency in the NEPA process at the earliest possible time.

(2) Use the environmental analysis and proposals of cooperating agencies with jurisdiction by law or special expertise, to the maximum extent possible consistent with its responsibility as lead agency.

(3) Meet with a cooperating agency at the latter's request.

(b) Each cooperating agency shall:

(1) Participate in the NEPA process at the earliest possible time.

(2) Participate in the scoping process (described below in § 1501.7).

(3) Assume on request of the lead agency responsibility for developing information and preparing environmental analyses including portions of the environmental impact statement concerning which the cooperating agency has special expertise.

(4) Make available staff support at the lead agency's request to enhance the latter's interdisciplinary capability.

(5) Normally use its own funds. The lead agency shall, to the extent available funds permit, fund those major activities or analyses it requests from cooperating agencies. Potential lead agencies shall include such funding requirements in their budget requests.

(c) A cooperating agency may in response to a lead agency's request for assistance in preparing the environmental impact statement (described in paragraph (b) (3), (4), or (5) of this section) reply that other program commitments preclude any involvement or the degree of involvement requested in the action that is the subject of the environmental impact statement. A copy of this reply shall be submitted to the Council.

§ 1501.7 SCOPING

There shall be an early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to a proposed action. This process shall be termed scoping. As soon as practicable after its decision to prepare an environmental impact statement and before

the scoping process the lead agency shall publish a notice of intent (§ 1508.22) in the Federal Register except as provided in § 1507.3(e).

(a) As part of the scoping process the lead agency shall:

(1) Invite the participation of affected Federal, State, and local agencies, any affected Indian tribe, the proponent of the action, and other interested persons (including those who might not be in accord with the action on environmental grounds), unless there is a limited exception under § 1507.3(c). An agency may give notice in accordance with § 1506.6.

(2) Determine the scope (§ 1508.25) and the significant issues to be analyzed in depth in the environmental impact statement.

(3) Identify and eliminate from detailed study the issues which are not significant or which have been covered by prior environmental review (§ 1506.3), narrowing the discussion of these issues in the statement to a brief presentation of why they will not have a significant effect on the human environment or providing a reference to their coverage elsewhere.

(4) Allocate assignments for preparation of the environmental impact statement among the lead and cooperating agencies, with the lead agency retaining responsibility for the statement.

(5) Indicate any public environmental assessments and other environmental impact statements which are being or will be prepared that are related to but are not part of the scope of the impact statement under consideration.

(6) Identify other environmental review and consultation requirements so the lead and cooperating agencies may prepare other required analyses and studies concurrently with, and integrated with, the environmental impact statement as provided in § 1502.25.

(7) Indicate the relationship between the timing of the preparation of environmental analyses and the agency's tentative planning and decision-making schedule.

(b) As part of the scoping process the lead agency may:

(1) Set page limits on environmental documents (§ 1502.7).

(2) Set time limits (§ 1501.8).

(3) Adopt procedures under § 1507.3 to combine its environmental assessment process with its scoping process.

(4) Hold an early scoping meeting or meetings which may be integrated with any other early planning meeting the agency has. Such a scoping meeting will often be appropriate when the impacts of a particular action are confined to specific sites.

(c) An agency shall revise the determinations made under paragraphs (a) and (b) of this section if substantial changes are made later in the proposed action, or if significant new circumstances or information arise which bear on the proposal or its impacts.

§ 1501.8 TIME LIMITS

Although the Council has decided that prescribed universal time limits for the entire NEPA process are too inflexible, Federal agencies are encouraged to set time limits appropriate to individual actions (consistent with the time intervals required by § 1506.10). When multiple agencies are involved the reference to agency below means lead agency.

(a) The agency shall set time limits if an applicant for the proposed action requests them: *Provided,* That the limits are consistent with the purposes of NEPA and other essential considerations of national policy.

(b) The agency may:

(1) Consider the following factors in determining time limits:

(i) Potential for environmental harm.

(ii) Size of the proposed action.

(iii) State of the art of analytic techniques.

(iv) Degree of public need for the proposed action, including the consequences of delay.

(v) Number of persons and agencies affected.

(vi) Degree to which relevant information is known and if not known the time required for obtaining it.

(vii) Degree to which the action is controversial.

(viii) Other time limits imposed on the agency by law, regulations, or executive order.

(2) Set overall time limits or limits for each constituent part of the NEPA process, which may include:

(i) Decision on whether to prepare an environmental impact statement (if not already decided).

(ii) Determination of the scope of the environmental impact statement.

(iii) Preparation of the draft environmental impact statement.

(iv) Review of any comments on the draft environmental impact statement from the public and agencies.

(v) Preparation of the final environmental impact statement.

(vi) Review of any comments on the final environmental impact statement.

(vii) Decision on the action based in part on the environmental impact statement.

(3) Designate a person (such as the project manager or a person in the agency's office with NEPA responsibilities) to expedite the NEPA process.

(c) State or local agencies or members of the public may request a Federal Agency to set time limits.

PART 1502—ENVIRONMENTAL IMPACT STATEMENT

1502.1 Purpose
1502.2 Implementation
1502.3 Statutory Requirements for Statements
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1502.24 Methodology and Scientific Accuracy
1502.25 Environmental Review and Consultation Requirements

Authority: NEPA, the Environmental Quality Improvement Act of 1970, as amended (42 U.S.C. 4371 et seq.), Section 309 of the Clean Air Act, as amended (42 U.S.C. 7609), and Executive Order 11514, Protection and En-

hancement of Environmental Quality (March 5, 1970, as amended by Executive Order 11991, May 24, 1977).

§ 1502.1 PURPOSE

The primary purpose of an environmental impact statement is to serve as an action-forcing device to insure that the policies and goals defined in the Act are infused into the ongoing programs and actions of the Federal Government. It shall provide full and fair discussion of significant environmental impacts and shall inform decisionmakers and the public of the reasonable alternatives which would avoid or minimize adverse impacts or enhance the quality of the human environment. Agencies shall focus on significant environmental issues and alternatives and shall reduce paperwork and the accumulation of extraneous background data. Statements shall be concise, clear, and to the point, and shall be supported by evidence that the agency has made the necessary environmental analyses. An environmental impact statement is more than a disclosure document. It shall be used by Federal officials in conjunction with other relevant material to plan actions and make decisions.

§ 1502.2 IMPLEMENTATION

To achieve the purposes set forth in § 1502.1 agencies shall prepare environmental impact statements in the following manner:

(a) Environmental impact statements shall be analytic rather than encyclopedic.

(b) Impacts shall be discussed in proportion to their significance. There shall be only brief discussion of other than significant issues. As in a finding of no significant impact, there should be only enough discussion to show why more study is not warranted.

(c) Environmental impact statements shall be kept concise and shall be no longer than absolutely necessary to comply with NEPA and with these regulations. Length should vary first with potential environmental problems and then with project size.

(d) Environmental impact statements shall state how alternatives considered in it and decisions based on it will or will not achieve the requirements of sections 101 and 102(1) of the Act and other environmental laws and policies.

(e) The range of alternatives discussed in environmental impact statements shall encompass those to be considered by the ultimate agency decisionmaker.

(f) Agencies shall not commit resources prejudicing selection of alternatives before making a final decision (§ 1506.1).

(g) Environmental impact statements shall serve as the means of assessing the environmental impact of proposed agency actions, rather than justifying decisions already made.

§ 1502.3 STATUTORY REQUIREMENTS FOR STATEMENTS

As required by sec. 102(2)(C) of NEPA environmental impact statements (§ 1508.11) are to be included in every recommendation or report
On proposals (§ 1508.23)
For legislation and (§ 1508.17)
Other major Federal actions (§ 1508.18)
Significantly (§ 1508.27)
Affecting (§§ 1508.3, 1508.8)
The quality of the human environment (§ 1508.14).

§ 1502.4 MAJOR FEDERAL ACTIONS REQUIRING THE PREPARATION OF ENVIRONMENTAL IMPACT STATEMENTS

(a) Agencies shall make sure the proposal which is the subject of an environmental impact statement is properly defined. Agencies shall use the criteria for scope (§ 1508.25) to determine which proposal(s) shall be the

subject of a particular statement. Proposals or parts of proposals which are related to each other closely enough to be, in effect, a single course of action shall be evaluated in a single impact statement.

(b) Environmental impact statements may be prepared, and are sometimes required, for broad Federal actions such as the adoption of new agency programs or regulations (§ 1508.18). Agencies shall prepare statements on broad actions so that they are relevant to policy and are timed to coincide with meaningful points in agency planning and decisionmaking.

(c) When preparing statements on broad actions (including proposals by more than one agency), agencies may find it useful to evaluate the proposal(s) in one of the following ways:

(1) Geographically, including actions occurring in the same general location, such as body of water, region, or metropolitan area.

(2) Generically, including actions which have relevant similarities, such as common timing, impacts, alternatives, methods of implementation, media, or subject matter.

(3) By stage of technological development including federal or federally assisted research, development or demonstration programs for new technologies which, if applied, could significantly affect the quality of the human environment. Statements shall be prepared on such programs and shall be available before the program has reached a stage of investment or commitment to implementation likely to determine subsequent development or restrict later alternatives.

(d) Agencies shall as appropriate employ scoping (§ 1501.7), tiering (§ 1502.20), and other methods listed in §§ 1500.4 and 1500.5 to relate broad and narrow actions and to avoid duplication and delay.

§ 1502.5 TIMING

An agency shall commence preparation of an environmental impact statement as close as possible to the time the agency is developing or is presented with a proposal (§ 1508.23) so that preparation can be completed in time for the final statement to be included in any recommendation or report on the proposal. The statement shall be prepared early enough so that it can serve practically as an important contribution to the decisionmaking process and will not be used to rationalize or justify decisions already made (§§ 1500.2(c), 1501.2, and 1502.2). For instance:

(a) For projects directly undertaken by Federal agencies the environmental impact statement shall be prepared at the feasibility analysis (go-no go) stage and may be supplemented at a later stage if necessary.

(b) For applications to the agency appropriate environmental assessments or statements shall be commenced no later than immediately after the application is received. Federal agencies are encouraged to begin preparation of such assessments or statements earlier, preferably jointly with applicable State or local agencies.

(c) For adjudication, the final environmental impact statement shall normally precede the final staff recommendation and that portion of the public hearing related to the impact study. In appropriate cirmumstances the statement may follow preliminary hearings designed to gather information for use in the statements.

(d) For informal rulemaking the draft environmental impact statement shall normally accompany the proposed rule.

§ 1502.6 INTERDISCIPLINARY PREPARATION

Environmental impact statements shall be prepared using an interdisciplinary approach which will insure the integrated use of the natural and social sciences and the environmental design arts (section 102(2)(A) of the Act). The disciplines of the preparers shall be appropriate to the scope and issues identified in the scoping process (§ 1501.7).

§ 1502.7 PAGE LIMITS

The text of final environmental impact statements (e.g., paragraphs (d) through (g) of § 1502.10) shall normally be less than 150 pages and for proposals of unusual scope or complexity shall normally be less than 300 pages.

§ 1502.8 WRITING

Environmental impact statements shall be written in plain language and may use appropriate graphics so that decisionmakers and the public can readily understand them. Agencies should employ writers of clear prose or editors to write, review, or edit statements, which will be based upon the analysis and supporting data from the natural and social sciences and the environmental design arts.

§ 1502.9 DRAFT, FINAL, AND SUPPLEMENTAL STATEMENTS

Except for proposals for legislation as provided in § 1506.8 environmental impact statements shall be prepared in two stages and may be supplemented.

(a) Draft environmental impact statements shall be prepared in accordance with the scope decided upon in the scoping process. The lead agency shall work with the cooperating agencies and shall obtain comments as required in Part 1503 of this chapter. The draft statement must fulfill and satisfy to the fullest extent possible the requirements established for final statements in section 102(2)(C) of the Act. If a draft statement is so inadequate as to preclude meaningful analysis, the agency shall prepare and circulate a revised draft of the appropriate portion. The agency shall make every effort to disclose and discuss at appropriate points in the draft statement all major points of view on the environmental impacts of the alternatives including the proposed action.

(b) Final environmental impact statements shall respond to comments as required in Part 1503 of this chapter. The agency shall discuss at appropriate points in the final statement any responsible opposing view which was not adequately discussed in the draft statement and shall indicate the agency's response to the issues raised.

(c) Agencies:

(1) Shall prepare supplements to either draft or final environmental impact statements if:

(i) The agency makes substantial changes in the proposed action that are relevant to environmental concerns; or

(ii) There are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts.

(2) May also prepare supplements when the agency determines that the purposes of the Act will be furthered by doing so.

(3) Shall adopt procedures for introducing a supplement into its formal administrative record, if such a record exists.

(4) Shall prepare, circulate, and file a supplement to a statement in the same fashion (exclusive of scoping) as a draft and final statement unless alternative procedures are approved by the Council.

§ 1502.10 RECOMMENDED FORMAT

Agencies shall use a format for environmental impact statements which will encourage good analysis and clear presentation of the alternatives including the proposed action. The following standard format for environmental impact statements should be followed unless the agency determines that there is a compelling reason to do otherwise:

(a) Cover sheet.

(b) Summary.

(c) Table of Contents.

(d) Purpose of and Need for Action.
(e) Alternatives Including Proposed Action (secs. 102(2)(C)(iii) and 102(2)(E) of the Act).
(f) Affected Environment.
(g) Environmental Consequences (especially sections 102(2)(C) (i), (ii), (iv), and (v) of the Act).
(h) List of Preparers.
(i) List of Agencies, Organizations, and Persons to Whom Copies of the Statement Are Sent.
(j) Index.
(k) Appendices (if any).

If a different format is used, it shall include paragraphs (a), (b), (c), (h), (i), and (j), of this section and shall include the substance of paragraphs (d), (e), (f), (g), and (k) of this section, as further described in §§ 1502.11–1502.18, in any appropriate format.

§ 1502.11 COVER SHEET

The cover sheet shall not exceed one page. It shall include:
(a) A list of the responsible agencies including the lead agency and any cooperating agencies.
(b) The title of the proposed action that is the subject of the statement (and if appropriate the titles of related cooperating agency actions), together with the State(s) and county(ies) (or other jurisdiction if applicable) where the action is located.
(c) The name, address, and telephone number of the person at the agency who can supply further information.
(d) A designation of the statement as a draft, final, or draft or final supplement.
(e) A one paragraph abstract of the statement.
(f) The date by which comments must be received (computed in cooperation with EPA under § 1506.10).
The information required by this section may be entered on Standard Form 424 (in items 4, 6, 7, 10, and 18).

§ 1502.12 SUMMARY

Each environmental impact statement shall contain a summary which adequately and accurately summarizes the statement. The summary shall stress the major conclusions, areas of controversy (including issues raised by agencies and the public), and the issues to be resolved (including the choice among alternatives). The summary will normally not exceed 15 pages.

§ 1502.13 PURPOSE AND NEED

The statement shall briefly specify the underlying purpose and need to which the agency is responding in proposing the alternatives including the proposed action.

§ 1502.14 ALTERNATIVES INCLUDING THE PROPOSED ACTION

This section in the heart of the environmental impact statement. Based on the information and analysis presented in the sections on the Affected Environment (§ 1502.15) and the Environmental Consequences (§ 1502.16), it should present the environmental impacts of the proposal and the alternatives in comparative form, thus sharply defining the issues and providing a clear basis for choice among options by the decisionmaker and the public. In this section agencies shall:
(a) Rigorously explore and objectively evaluate all reasonable alternatives, and for alternatives which were eliminated from detailed study, briefly discuss the reasons for their having been eliminated.

(b) Devote substantial treatment to each alternative considered in detail including the proposed action so that reviewers may evaluate their comparative merits.

(c) Include reasonable alternatives not within the jurisdiction of the lead agency.

(d) Include the alternative of no action.

(e) Identify the agency's preferred alternative or alternatives, if one or more exists, in the draft statement and identify such alternative in the final statement unless another law prohibits the expression of such a preference.

(f) Include appropriate mitigation measures not already included in the proposed action or alternatives.

§ 1502.15 AFFECTED ENVIRONMENT

The environmental impact statement shall succinctly describe the environment of the area(s) to be affected or created by the alternatives under consideration. The descriptions shall be no longer than is necessary to understand the effects of the alternatives. Data and analyses in a statement shall be commensurate with the importance of the impact, with less important material summarized, consolidated, or simply referenced. Agencies shall avoid useless bulk in statements and shall concentrate effort and attention on important issues. Verbose descriptions of the affected environment are themselves no measure of the adequacy of an environmental impact statement.

§ 1502.16 ENVIRONMENTAL CONSEQUENCES

This section forms the scientific and analytic basis for the comparisons under § 1502.14. It shall consolidate the discussions of those elements required by secs. 102(2)(C) (i), (ii), (iv), and (v) of NEPA which are within the scope of the statement and as much of sec. 102(2)(C)(iii) as is necessary to support the comparisons. The discussion will include the environmental impacts of the alternatives including the proposed action, any adverse environmental effects which cannot be avoided should the proposal be implemented, the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and any irreversible or irretrievable commitments of resources which would be involved in the proposal should it be implemented. This section should not duplicate discussions in § 1502.14. It shall include discussions of:

(a) Direct effects and their significance (§ 1508.8).

(b) Indirect effects and their significance (§ 1508.8).

(c) Possible conflicts between the proposed action and the objectives of Federal, regional, State, and local (and in the case of a reservation, Indian tribe) land use plans, policies and controls for the area concerned. (See § 1506.2(d).)

(d) The environmental effects of alternatives including the proposed action. The comparisons under § 1502.14 will be based on this discussion.

(e) Energy requirements and conservation potential of various alternatives and mitigation measures.

(f) Natural or depletable resource requirements and conservation potential of various alternatives and mitigation measures.

(g) Urban quality, historic and cultural resources, and the design of the built environment, including the reuse and conservation potential of various alternatives and mitigation measures.

(h) Means to mitigate adverse environmental impacts (if not fully covered under § 1502.14(f)).

§ 1502.17 LIST OF PREPARERS

The environmental impact statement shall list the names, together with their qualifications (expertise, experience, professional disciplines), of the persons who were primarily responsible for preparing the environmental impact statement or significant background papers, including basic components

of the statement (§§ 1502.6 and 1502.8). Where possible the persons who are responsible for a particular analysis, including analyses in background papers, shall be identified. Normally the list will not exceed two pages.

§ 1502.18 APPENDIX

If an agency prepares an appendix to an environmental impact statement the appendix shall:

(a) Consist of material prepared in connection with an environmental impact statement (as distinct from material which is not so prepared and which is incorporated by reference (§ 1502.21)).

(b) Normally consist of material which substantiates any analysis fundamental to the impact statement.

(c) Normally be analytic and relevant to the decision to be made.

(d) Be circulated with the environmental impact statement or be readily available on request.

§ 1502.19 CIRCULATION OF THE ENVIRONMENTAL IMPACT STATEMENT

Agencies shall circulate the entire draft and final environmental impact statements except for certain appendices as provided in § 1502.18(d) and unchanged statements as provided in § 1503.4(c). However, if the statement is unusually long, the agency may circulate the summary instead, except that the entire statement shall be furnished to:

(a) Any Federal agency which has jurisdiction by law or special expertise with respect to any environmental impact involved and any appropriate Federal, State or local agency authorized to develop and enforce environmental standards.

(b) The applicant, if any.

(c) Any person, organization, or agency requesting the entire environmental impact statement.

(d) In the case of a final environmental impact statement any person, organization, or agency which submitted substantive comments on the draft.

If the agency circulates the summary and thereafter receives a timely request for the entire statement and for additional time to comment, the time for that requestor only shall be extended by at least 15 days beyond the minimum period.

§ 1502.20 TIERING

Agencies are encouraged to tier their environmental impact statements to eliminate repetitive discussions of the same issues and to focus on the actual issues ripe for decision at each level of environmental review (§ 1508.28). Whenever a broad environmental impact statement has been prepared (such as a program or policy statement) and a subsequent statement or environmental assessment is then prepared on an action included within the entire program or policy (such as a site-specific action) the subsequent statement or environmental assessment need only summarize the issues discussed in the broader statement and incorporate discussions from the broader statement by reference and shall concentrate on the issues specific to the subsequent action. The subsequent document shall state where the earlier document is available. Tiering may also be appropriate for different stages of actions. (Sec. 1508.28).

§ 1502.21 INCORPORATION BY REFERENCE

Agencies shall incorporate material into an environmental impact statement by reference when the effect will be to cut down on bulk without impeding agency and public review of the action. The incorporated material shall be cited in the statement and its content briefly described. No material may be incorporated by reference unless it is reasonably available for inspec-

tion by potentially interested persons within the time allowed for comment. Material based on proprietary data which is itself not available for review and comment shall not be incorporated by reference.

§ 1502.22 INCOMPLETE OR UNAVAILABLE INFORMATION

When an agency is evaluating significant adverse effects on the human environment in an environmental impact statement and there are gaps in relevant information or scientific uncertainty, the agency shall always make clear that such information is lacking or that uncertainty exists.

(a) If the information relevant to adverse impacts is essential to a reasoned choice among alternatives and is not known and the overall costs of obtaining it are not exorbitant, the agency shall include the information in the environmental impact statement.

(b) If (1) the information relevant to adverse impacts is essential to a reasoned choice among alternatives and is not known and the overall costs of obtaining it are exorbitant or (2) the information relevant to adverse impacts is important to the decision and the means to obtain it are not known (e.g., the means for obtaining it are beyond the state of the art) the agency shall weigh the need for the action against the risk and severity of possible adverse impacts were the action to proceed in the face of uncertainty. If the agency proceeds, it shall include a worst case analysis and an indication of the probability or improbability of its occurrence.

§ 1502.23 COST-BENEFIT ANALYSIS

If a cost-benefit analysis relevant to the choice among environmentally different alternatives is being considered for the proposed action, it shall be incorporated by reference or appended to the statement as an aid in evaluating the environmental consequences. To assess the adequacy of compliance with sec. 102(2)(B) of the Act the statement shall, when a cost-benefit analysis is prepared, discuss the relationship between that analysis and any analyses of unquantified environmental impacts, values, and amenities. For purposes of complying with the Act, the weighing of the merits and drawbacks of the various alternatives need not be displayed in a monetary cost-benefit analysis and should not be when there are important qualitative considerations. In any event, an environmental impact statement should at least indicate those considerations, including factors not related to environmental quality, which are likely to be relevant and important to a decision.

§ 1502.24 METHODOLOGY AND SCIENTIFIC ACCURACY

Agencies shall insure the professional integrity, including scientific integrity, of the discussions and analyses in environmental impact statements. They shall identify any methodologies used and shall make explicit reference by footnote to the scientific and other sources relied upon for conclusions in the statement. An agency may place discussion of methodology in an appendix.

§ 1502.25 ENVIRONMENTAL REVIEW AND CONSULTATION REQUIREMENTS

(a) To the fullest extent possible, agencies shall prepare draft environmental impact statements concurrently with and integrated with environmental impact analyses and related surveys and studies required by the Fish and Wildlife Coordination Act (16 U.S.C. Sec. 661 et seq.), the National Historic Preservation Act of 1966 (16 U.S.C. Sec. 470 et seq.), the Endangered Species Act of 1973 (16 U.S.C. Sec 1531 et seq.), and other environmental review laws and executive orders.

(b) The draft environmental impact statement shall list all Federal permits, licenses, and other entitlements which must be obtained in implementing the proposal. If it is uncertain whether a Federal permit, license, or other entitlement is necessary, the draft environmental impact statement shall so indicate.

PART 1503—COMMENTING

1503.1 Inviting Comments
1503.2 Duty to Comment
1503.3 Specificity of Comments
1503.4 Response to Comments

AUTHORITY: NEPA, the Environmental Quality Improvement Act of 1970, as amended (42 U.S.C. 4371 et seq.), Section 309 of the Clean Air Act, as amended (42 U.S.C. 7609), and Executive Order 11514, Protection and Enhancement of Environmental Quality (March 5, 1970, as amended by Executive Order 11991, May 24, 1977).

§ 1503.1 INVITING COMMENTS

(a) After preparing a draft environmental impact statement and before preparing a final environmental impact statement the agency shall:

(1) Obtain the comments of any Federal agency which has jurisdiction by law or special expertise with respect to any environmental impact involved or which is authorized to develop and enforce environmental standards.

(2) Request the comments of:

(i) Appropriate State and local agencies which are authorized to develop and enforce environmental standards;

(ii) Indian tribes, when the effects may be on a reservation; and

(iii) Any agency which has requested that it receive statements on actions of the kind proposed.

Office of Management and Budget Circular A–95 (Revised), through its system of clearinghouses, provides a means of securing the views of State and local environmental agencies. The clearinghouses may be used, by mutual agreement of the lead agency and the clearinghouse, for securing State and local reviews of the draft environmental impact statements.

(3) Request comments from the applicant, if any.

(4) Request comments from the public, affirmatively soliciting comments from those persons or organizations who may be interested or affected.

(b) An agency may request comments on a final environmental impact statement before the decision is finally made. In any case other agencies or persons may make comments before the final decision unless a different time is provided under § 1506.10.

§ 1503.2 DUTY TO COMMENT

Federal agencies with jurisdiction by law or special expertise with respect to any environmental impact involved and agencies which are authorized to develop and enforce environmental standards shall comment on statements within their jurisdiction, expertise, or authority. Agencies shall comment within the time period specified for comment in § 1506.10. A Federal agency may reply that it has no comment. If a cooperating agency is satisfied that its views are adequately reflected in the environmental impact statement, it should reply that it has no comment.

§ 1503.3 SPECIFICITY OF COMMENTS

(a) Comments on an environmental impact statement or on a proposed action shall be as specific as possible and may address either the adequacy of the statement or the merits of the alternatives discussed or both.

(b) When a commenting agency criticizes a lead agency's predictive methodology, the commenting agency should describe the alternative methodology which it prefers and why.

(c) A cooperating agency shall specify in its comments whether it needs additional information to fulfill other applicable environmental reviews or consultation requirements and what information it needs. In particular, it shall specify any additional information it needs to comment adequately on the draft statement's analysis of significant site-specific effects associated with the granting or approving by that cooperating agency of necessary Federal permits, licenses, or entitlements.

(d) When a cooperating agency with jurisdiction by law objects to or expresses reservations about the proposal on grounds of environmental impacts, the agency expressing the objection or reservation shall specify the mitigation measures it considers necessary to allow the agency to grant or approve applicable permit, license, or related requirements or concurrences.

§ 1503.4 RESPONSE TO COMMENTS

(a) An agency preparing a final environmental impact statement shall assess and consider comments both individually and collectively, and shall respond by one or more of the means listed below, stating its response in the final statement. Possible responses are to:

(1) Modify alternatives including the proposed action.

(2) Develop and evaluate alternatives not previously given serious consideration by the agency.

(3) Supplement, improve, or modify its analyses.

(4) Make factual corrections.

(5) Explain why the comments do not warrant further agency response, citing the sources, authorities, or reasons which support the agency's position and, if appropriate, indicate those circumstances which would trigger agency reappraisal or further response.

(b) All substantive comments received on the draft statement (or summaries thereof where the response has been exceptionally voluminous), should be attached to the final statement whether or not the comment is thought to merit individual discussion by the agency in the text of the statement.

(c) If changes in response to comments are minor and are confined to the responses described in paragraphs (a) (4) and (5) of this section, agencies may write them on errata sheets and attach them to the statement instead of rewriting the draft statement. In such cases only the comments, the responses, and the changes and not the final statement need be circulated (§ 1502.19). The entire document with a new cover sheet shall be filed as the final statement (§ 1506.9).

PART 1504—PREDECISION REFERRALS TO THE COUNCIL OF PROPOSED FEDERAL ACTIONS DETERMINED TO BE ENVIRONMENTALLY UNSATISFACTORY

1504.1 Purpose
1504.2 Criteria for Referral
1504.3 Procedure for Referrals and Response

AUTHORITY: NEPA, the Environmental Quality Improvement Act of 1970, as amended (42 U.S.C. 4371 et seq.), Section 309 of the Clean Air Act, as amended (42 U.S.C. 7609), and Executive Order 11514, Protection and Enhancement of Environmental Quality (March 5, 1970, as amended by Executive Order 11991, May 24, 1977).

§ 1504.1 PURPOSE

(a) This part establishes procedures for referring to the Council Federal interagency disagreements concerning proposed major Federal actions that might cause unsatisfactory environmental effects. It provides means for early resolution of such disagreements.

(b) Under section 309 of the Clean Air Act (42 U.S.C. 7609), the Administrator of the Environmental Protection Agency is directed to review and comment publicly on the environmental impacts of Federal activities, including actions for which environmental impact statements are prepared. If after this review the Administrator determines that the matter is "unsatisfactory from the standpoint of public health or welfare or environmental quality," section 309 directs that the matter be referred to the Council (hereafter "environmental referrals").

(c) Under section 102(2)(C) of the Act other Federal agencies may make similar reviews of environmental impact statements, including judgments on the acceptability of anticipated environmental impacts. These reviews must be made available to the President, the Council and the public.

§ 1504.2 CRITERIA FOR REFERRAL

Environmental referrals should be made to the Council only after concerted, timely (as early as possible in the process), but unsuccessful attempts to resolve differences with the lead agency. In determining what environmental objections to the matter are appropriate to refer to the Council, an agency should weigh potential adverse environmental impacts, considering:

(a) Possible violation of national environmental standards or policies.
(b) Severity.
(c) Geographical scope.
(d) Duration.
(e) Importance as precedents.
(f) Availability of environmentally preferable alternatives.

§ 1504.3 PROCEDURE FOR REFERRALS AND RESPONSE

(a) A Federal agency making the referral to the Council shall:

(1) Advise the lead agency at the earliest possible time that it intends to refer a matter to the Council unless a satisfactory agreement is reached.

(2) Include such advice in the referring agency's comments on the draft environmental impact statement, except when the statement does not contain adequate information to permit an assessment of the matter's environmental acceptability.

(3) Identify any essential information that is lacking and request that it be made available at the earliest possible time.

(4) Send copies of such advice to the Council.

(b) The referring agency shall deliver its referral to the Council not later than twenty-five (25) days after the final environmental impact statement has been made available to the Environmental Protection Agency, commenting agencies, and the public. Except when an extension of this period has been granted by the lead agency, the Council will not accept a referral after that date.

(c) The referral shall consist of:

(1) A copy of the letter signed by the head of the referring agency and delivered to the lead agency informing the lead agency of the referral and the reasons for it, and requesting that no action be taken to implement the matter until the Council acts upon the referral. The letter shall include a copy of the statement referred to in (c)(2) below.

(2) A statement supported by factual evidence leading to the conclusion that the matter is unsatisfactory from the standpoint of public health or welfare or environmental quality. The statement shall:

(i) Identify any material facts in controversy and incorporate (by reference if appropriate) agreed upon facts,

(ii) Identify any existing environmental requirements or policies which would be violated by the matter,

(iii) Present the reasons why the referring agency believes the matter is environmentally unsatisfactory,

(iv) Contain a finding by the agency whether the issue raised is of national importance because of the threat to national environmental resources or policies or for some other reason,

(v) Review the steps taken by the referring agency to bring its concerns to the attention of the lead agency at the earliest possible time, and

(vi) Give the referring agency's recommendations as to what mitigation alternative, further study, or other course of action (including abandonment of the matter) are necessary to remedy the situation.

(d) Not later than twenty-five (25) days after the referral to the Council the lead agency may deliver a response to the Council and the referring agency. If the lead agency requests more time and gives assurance that the matter will not go forward in the interim, the Council may grant an extension. The response shall:

(1) Address fully the issues raised in the referral.

(2) Be supported by evidence.

(3) Give the lead agency's response to the referring agency's recommendations.

(e) Interested persons (including the applicant) may deliver their views in writing to the Council. Views in support of the referral should be delivered not later than the referral. Views in support of the response shall be delivered not later than the response.

(f) Not later than twenty-five (25) days after receipt of both the referral and any response or upon being informed that there will be no response (unless the lead agency agrees to a longer time), the Council may take one or more of the following actions:

(1) Conclude that the process of referral and response has successfully resolved the problem.

(2) Initiate discussions with the agencies with the objective of mediation with referring and lead agencies.

(3) Hold public meetings or hearings to obtain additional views and information.

(4) Determine that the issue is not one of national importance and request the referring and lead agencies to pursue their decision process.

(5) Determine that the issue should be further negotiated by the referring and lead agencies and is not appropriate for Council consideration until one or more heads of agencies report to the Council that the agencies' disagreements are irreconcilable.

(6) Publish its findings and recommendations (including where appropriate a finding that the submitted evidence does not support the position of an agency).

(7) When appropriate, submit the referral and the response together with the Council's recommendation to the President for action.

(g) The Council shall take no longer than 60 days to complete the actions specified in paragraph (f) (2), (3), or (5) of this section.

(h) When the referral involves an action required by statute to be determined on the record after opportunity for agency hearing, the referral shall be conducted in a manner consistent with 5 U.S.C. 557(d) (Administrative Procedure Act).

PART 1505—NEPA AND AGENCY DECISIONMAKING

1505.1 Agency decisionmaking procedures
1505.2 Record of decision in cases requiring environmental impact statements
1505.3 Implementing the decision

AUTHORITY: NEPA, the Environmental Quality Improvement Act of 1970, as amended (42 U.S.C. 4371 et seq.), Section 309 of the Clean Air Act, as

amended (42 U.S.C. 7609), and Executive Order 11514, Protection and Enhancement of Environmental Quality (March 5, 1970, as amended by Executive Order 11991, May 24, 1977).

§ 1505.1 AGENCY DECISIONMAKING PROCEDURES

Agencies shall adopt procedures (§ 1507.3) to ensure that decisions are made in accordance with the policies and purposes of the Act. Such procedures shall include but not be limited to:

(a) Implementing procedures under section 102(2) to achieve the requirements of sections 101 and 102(1).

(b) Designating the major decision points for the agency's principal programs likely to have a significant effect on the human environment and assuring that the NEPA process corresponds with them.

(c) Requiring that relevant environmental documents, comments, and responses be part of the record in formal rulemaking or adjudicatory proceedings.

(d) Requiring that relevant environmental documents, comments, and responses accompany the proposal through existing agency review processes so that agency officials use the statement in making decisions.

(e) Requiring that the alternatives considered by the decisionmaker are encompassed by the range of alternatives discussed in the relevant environmental documents and that the decisionmaker consider the alternatives described in the environmental impact statement. If another decision document accompanies the relevant environmental documents to the decisionmaker, agencies are encouraged to make available to the public before the decision is made any part of that document that relates to the comparison of alternatives.

§ 1505.2 RECORD OF DECISION IN CASES REQUIRING ENVIRONMENTAL IMPACT STATEMENTS

At the time of its decision (§ 1506.10) or, if appropriate, its recommendation to Congress, each agency shall prepare a concise public record of decision. The record, which may be integrated into any other record prepared by the agency, including that required by OMB Circular A–95 (Revised), part I, sections 6 (c) and (d), and part II, section 5(b)(4), shall:

(a) State what the decision was.

(b) Identify all alternatives considered by the agency in reaching its decision, specifying the alternative or alternatives which were considered to be environmentally preferable. An agency may discuss preferences among alternatives based on relevant factors including economic and technical considerations and agency statutory missions. An agency shall identify and discuss all such factors including any essential considerations of national policy which were balanced by the agency in making its decision and state how those considerations entered into its decision.

(c) State whether all practicable means to avoid or minimize environmental harm from the alternative selected have been adopted, and if not, why they were not. A monitoring and enforcement program shall be adopted and summarized where applicable for any mitigation.

§ 1505.3 IMPLEMENTING THE DECISION

Agencies may provide for monitoring to assure that their decisions are carried out and should do so in important cases. Mitigation (§ 1505.2(c)) and other conditions established in the environmental impact statement or during its review and committed as part of the decision shall be implemented by the lead agency or other appropriate consenting agency. The lead agency shall:

(a) Include appropriate conditions in grants, permits or other approvals.

(b) Condition funding of actions on mitigation.

(c) Upon request, inform cooperating or commenting agencies on progress in carrying out mitigation measures which they have proposed and which were adopted by the agency making the decision.

(d) Upon request, make available to the public the results of relevant monitoring.

PART 1506—OTHER REQUIREMENTS OF NEPA

1506.1 Limitations on actions during NEPA process
1506.2 Elimination of duplication with State and local procedures
1506.3 Adoption
1506.4 Combining documents
1506.5 Agency responsibility
1506.6 Public involvement
1506.7 Further guidance
1506.8 Proposals for legislation
1506.9 Filing requirements
1506.10 Timing of agency action
1506.11 Emergencies
1506.12 Effective date

AUTHORITY: NEPA, the Environmental Quality Improvement Act of 1970, as amended (42 U.S.C. 4371 et seq.), Section 309 of the Clean Air Act, as amended (42 U.S.C. 7609), and Executive Order 11514, Protection and Enhancement of Environmental Quality (March 5, 1970, as amended by Executive Order 11991, May 24, 1977).

§ 1506.1 LIMITATIONS ON ACTIONS DURING NEPA PROCESS

(a) Until an agency issues a record of decision as provided in § 1505.2 (except as provided in paragraph (c) of this section), no action concerning the proposal shall be taken which would:

(1) Have an adverse environmental impact; or

(2) Limit the choice of reasonable alternatives.

(b) If any agency is considering an application from a non-Federal entity, and is aware that the applicant is about to take an action within the agency's jurisdiction that would meet either of the criteria in paragraph (a) of this section, then the agency shall promptly notify the applicant that the agency will take appropriate action to insure that the objectives and procedures of NEPA are achieved.

(c) While work on a required program environmental impact statement is in progress and the action is not covered by an existing program statement, agencies shall not undertake in the interim any major Federal action covered by the program which may significantly affect the quality of the human environment unless such action:

(1) Is justified independently of the program;

(2) Is itself accompanied by an adequate environmental impact statement; and

(3) Will not prejudice the ultimate decision on the program. Interim action prejudices the ultimate decision on the program when it tends to determine subsequent development or limit alternatives.

(d) This section does not preclude development by applicants of plans or designs or performance of other work necessary to support an application for Federal, State or local permits or assistance. Nothing in this section shall preclude Rural Electrification Administration approval of minimal expenditures not affecting the environment (*e.g.* long leadtime equipment and purchase options) made by non-governmental entities seeking loan guarantees from the Administration.

§ 1506.2 ELIMINATION OF DUPLICATION WITH STATE AND LOCAL PROCEDURES

(a) Agencies authorized by law to cooperate with State agencies of statewide jurisdiction pursuant to section 102(2)(D) of the Act may do so.

(b) Agencies shall cooperate with State and local agencies to the fullest extent possible to reduce duplication between NEPA and State and local requirements, unless the agencies are specifically barred from doing so by some other law. Except for cases covered by paragraph (a) of this section, such cooperation shall to the fullest extent possible include:

(1) Joint planning processes.
(2) Joint environmental research and studies.
(3) Joint public hearings (except where otherwise provided by statute).
(4) Joint environmental assessments.

(c) Agencies shall cooperate with State and local agencies to the fullest extent possible to reduce duplication between NEPA and comparable State and local requirements, unless the agencies are specifically barred from doing so by some other law. Except for cases covered by paragraph (a) of this section, such cooperation shall to the fullest extent possible include joint environmental impact statements. In such cases one or more Federal agencies and one or more State or local agencies shall be joint lead agencies. Where State laws or local ordinances have environmental impact statement requirements in addition to but not in conflict with those in NEPA, Federal agencies shall cooperate in fulfilling these requirements as well as those of Federal laws so that one document will comply with all applicable laws.

(d) To better integrate environmental impact statements into State or local planning processes, statements shall discuss any inconsistency of a proposed action with any approved State or local plan and laws (whether or not federally sanctioned). Where an inconsistency exists, the statement should describe the extent to which the agency would reconcile its proposed action with the plan or law.

§ 1506.3 ADOPTION

(a) An agency may adopt a Federal draft or final environmental impact statement or portion thereof provided that the statement or portion thereof meets the standards for an adequate statement under these regulations.

(b) If the actions covered by the original environmental impact statement and the proposed action are substantially the same, the agency adopting another agency's statement is not required to recirculate it except as a final statement. Otherwise the adopting agency shall treat the statement as a draft and recirculate it (except as provided in paragraph (c) of this section).

(c) A cooperating agency may adopt without recirculating the environmental impact statement of a lead agency when, after an independent review of the statement, the cooperating agency concludes that its comments and suggestions have been satisfied.

(d) When an agency adopts a statement which is not final within the agency that prepared it, or when the action it assesses is the subject of a referral under part 1504, or when the statement's adequacy is the subject of a judicial action which is not final, the agency shall so specify.

§ 1506.4 COMBINING DOCUMENTS

Any environmental document in compliance with NEPA may be combined with any other agency document to reduce duplication and paperwork.

§ 1506.5 AGENCY RESPONSIBILITY

(a) *Information.* If an agency requires an applicant to submit environmental information for possible use by the agency in preparing an environmental

impact statement, then the agency should assist the applicant by outlining the types of information required. The agency shall independently evaluate the information submitted and shall be responsible for its accuracy. If the agency chooses to use the information submitted by the applicant in the environmental impact statement, either directly or by reference, then the names of the persons responsible for the independent evaluation shall be included in the list of preparers (§ 1502.17). It is the intent of this subparagraph that acceptable work not be redone, but that it be verified by the agency.

(b) *Environmental assessments.* If an agency permits an applicant to prepare an environmental assessment, the agency, besides fulfilling the requirements of paragraph (a) of this section, shall make its own evaluation of the environmental issues and take responsibility for the scope and content of the environmental assessment.

(c) *Environmental impact statements.* Except as provided in §§ 1506.2 and 1506.3 any environmental impact statement prepared pursuant to the requirements of NEPA shall be prepared directly by or by a contractor selected by the lead agency or where appropriate under § 1501.6(b), a cooperating agency. It is the intent of these regulations that the contractor be chosen solely by the lead agency, or by the lead agency in cooperation with cooperating agencies, or where appropriate by a cooperating agency to avoid any conflict of interest. Contractors shall execute a disclosure statement prepared by the lead agency, or where appropriate the cooperating agency, specifying that they have no financial or other interest in the outcome of the project. If the document is prepared by contract, the responsible Federal official shall furnish guidance and participate in the preparation and shall independently evaluate the statement prior to its approval and take responsibility for its scope and contents. Nothing in this section is intended to prohibit any agency from requesting any person to submit information to it or to prohibit any person from submitting information to any agency.

§ 1506.6 PUBLIC INVOLVEMENT

Agencies shall: (a) Make diligent efforts to involve the public in preparing and implementing their NEPA procedures.

(b) Provide public notice of NEPA-related hearings, public meetings, and the availability of environmental documents so as to inform those persons and agencies who may be interested or affected.

(1) In all cases the agency shall mail notice to those who have requested it on an individual action.

(2) In the case of an action with effects of national concern notice shall include publication in the FEDERAL REGISTER and notice by mail to national organizations reasonably expected to be interested in the matter and may include listing in the *102 Monitor*. An agency engaged in rulemaking may provide notice by mail to national organizations who have requested that notice regularly be provided. Agencies shall maintain a list of such organizations.

(3) In the case of an action with effects primarily of local concern the notice may include:

(i) Notice to State and areawide clearinghouses pursuant to OMB Circular A–95 (Revised).

(ii) Notice to Indian tribes when effects may occur on reservations.

(iii) Following the affected State's public notice procedures for comparable actions.

(iv) Publication in local newspapers (in papers of general circulation rather than legal papers).

(v) Notice through other local media.

(vi) Notice to potentially interested community organizations including small business associations.

(vii) Publication in newsletters that may be expected to reach potentially interested persons.

(viii) Direct mailing to owners and occupants of nearby or affected property.

(ix) Posting of notice on and off site in the area where the action is to be located.

(c) Hold or sponsor public hearings or public meetings whenever appropriate or in accordance with statutory requirements applicable to the agency. Criteria shall include whether there is:

(1) Substantial environmental controversy concerning the proposed action or substantial interest in holding the hearing.

(2) A request for a hearing by another agency with jurisdiction over the action supported by reasons why a hearing will be helpful. If a draft environmental impact statement is to be considered at a public hearing, the agency should make the statement available to the public at least 15 days in advance (unless the purpose of the hearing is to provide information for the draft environmental impact statement).

(d) Solicit appropriate information from the public.

(e) Explain in its procedures where interested persons can get information or status reports on environmental impact statements and other elements of the NEPA process.

(f) Make environmental impact statements, the comments received, and any underlying documents available to the public pursuant to the provisions of the Freedom of Information Act (5 U.S.C. 552), without regard to the exclusion for interagency memoranda where such memoranda transmit comments of Federal agencies on the environmental impact of the proposed action. Materials to be made available to the public shall be provided to the public without charge to the extent practicable, or at a fee which is not more than the actual costs of reproducing copies required to be sent to other Federal agencies, including the Council.

§ 1506.7 FURTHER GUIDANCE

The Council may provide further guidance concerning NEPA and its procedures including:

(a) A handbook which the Council may supplement from time to time, which shall in plain language provide guidance and instructions concerning the application of NEPA and these regulations.

(b) Publication of the Council's Memoranda to Heads of Agencies.

(c) In conjunction with the Environmental Protection Agency and the publication of the 102 Monitor, notice of:

(1) Research activities;

(2) Meetings and conferences related to NEPA; and

(3) Successful and innovative procedures used by agencies to implement NEPA.

§ 1506.8 PROPOSALS FOR LEGISLATION

(a) The NEPA process for proposals for legislation (§ 1508.17) significantly affecting the quality of the human environment shall be integrated with the legislative process of the Congress. A legislative environmental impact statement is the detailed statement required by law to be included in a recommendation or report on a legislative proposal to Congress. A legislative environmental impact statement shall be considered part of the formal transmittal of a legislative proposal to Congress; however, it may be transmitted to Congress up to 30 days later in order to allow time for completion of an accurate statement which can serve as the basis for public and Congressional debate. The statement must be available in time for Congressional hearings and deliberations.

(b) Preparation of a legislative environmental impact statement shall conform to the requirements of these regulations except as follows:

(1) There need not be a scoping process.

(2) The legislative statement shall be prepared in the same manner as a draft statement, but shall be considered the "detailed statement" required by statute; *Provided,* That when any of the following conditions exist both the draft and final environmental impact statement on the legislative proposal shall be prepared and circulated as provided by §§ 1503.1 and 1506.10.

(i) A Congressional Committee with jurisdiction over the proposal has a rule requiring both draft and final environmental impact statements.

(ii) The proposal results from a study process required by statute (such as those required by the Wild and Scenic Rivers Act (16 U.S.C. 1271 et seq.) and the Wilderness Act (16 U.S.C. 1131 et seq.)).

(iii) Legislative approval is sought for Federal or federally assisted construction or other projects which the agency recommends be located at specific geographic locations. For proposals requiring an environmental impact statement for the acquisition of space by the General Services Administration, a draft statement shall accompany the Prospectus or the 11(b) Report of Building Project Surveys to the Congress, and a final statement shall be completed before site acquisition.

(iv) The agency decides to prepare draft and final statements.

(c) Comments on the legislative statement shall be given to the lead agency which shall forward them along with its own responses to the Congressional committees with jurisdiction.

§ 1506.9 FILING REQUIREMENTS

Environmental impact statements together with comments and responses shall be filed with the Environmental Protection Agency, attention Office of Federal Activities (A–104), 401 M Street SW, Washington, D.C. 20460. Statements shall be filed with EPA no earlier than they are also transmitted to commenting agencies and made available to the public. EPA shall deliver one copy of each statement to the Council, which shall satisfy the requirement of availability to the President. EPA may issue guidelines to agencies to implement its responsibilities under this section and § 1506.10 below.

§ 1506.10 TIMING OF AGENCY ACTION

(a) The Environmental Protection Agency shall publish a notice in the FEDERAL REGISTER each week of the environmental impact statements filed during the preceding week. The minimum time periods set forth in this section shall be calculated from the date of publication of this notice.

(b) No decision on the proposed action shall be made or recorded under § 1505.2 by a Federal agency until the later of the following dates:

(1) Ninety (90) days after publication of the notice described above in paragraph (a) of this section for a draft environmental impact statement.

(2) Thirty (30) days after publication of the notice described above in paragraph (a) of this section for a final environmental impact statement.

An exception to the rules on timing may be made in the case of an agency decision which is subject to a formal internal appeal. Some agencies have a formally established appeal process which allows other agencies or the public to take appeals on a decision and make their views known, after publication of the final environmental impact statement. In such cases, where a real opportunity exists to alter the decision, the decision may be made and recorded at the same time the environmental impact statement is published. This means that the period for appeal of the decision and the 30-day period prescribed in paragraph (b)(2) of this section may run concurrently. In such cases the environmental impact statement shall explain the timing and the public's right of appeal.

An agency engaged in rulemaking under the Administrative Procedure Act or other statute for the purpose of protecting the public health or safety, may waive the time period in paragraph (b)(2) of this section and publish a decision on the final rule simultaneously with publication of the notice of the availability of the final environmental impact statement as described in paragraph (a) of this section.

(c) If the final environmental impact statement is filed within ninety (90) days after a draft environmental impact statement is filed with the Environmental Protection Agency, the minimum thirty (30) day period and the minimum ninety (90) day period may run concurrently. However, subject to paragraph (d) of this section agencies shall allow not less than 45 days for comments on draft statements.

(d) The lead agency may extend prescribed periods. The Environmental Protection Agency may upon a showing by the lead agency of compelling reasons of national policy reduce the prescribed periods and may upon a showing by any other Federal agency of compelling reasons of national policy also extend prescribed periods, but only after consultation with the lead agency. (Also see § 1507.3(d).) Failure to file timely comments shall not be a sufficient reason for extending a period. If the lead agency does not concur with the extension of time, EPA may not extend it for more than 30 days. When the Environmental Protection Agency reduces or extends any period of time it shall notify the Council.

§ 1506.11 EMERGENCIES

Where emergency circumstances make it necessary to take an action with significant environmental impact without observing the provisions of these regulations, the Federal agency taking the action should consult with the Council about alternative arrangements. Agencies and the Council will limit such arrangements to actions necessary to control the immediate impacts of the emergency. Other actions remain subject to NEPA review.

§ 1506.12 EFFECTIVE DATE

The effective date of these regulations is July 30, 1979, except that for agencies that administer programs that qualify under sec. 102(2)(D) of the Act or under sec. 104(h) of the Housing and Community Development Act of 1974 an additional four months shall be allowed for the State or local agencies to adopt their implementing procedures.

(a) These regulations shall apply to the fullest extent practicable to ongoing activities and environmental documents begun before the effective date. These regulations do not apply to an environmental impact statement or supplement if the draft statement was filed before the effective date of these regulations. No completed environmental documents need be redone by reason of these regulations. Until these regulations are applicable, the Council's guidelines published in the FEDERAL REGISTER of August 1, 1973, shall continue to be applicable. In cases where these regulations are applicable the guidelines are superseded. However, nothing shall prevent an agency from proceeding under these regulations at an earlier time.

(b) NEPA shall continue to be applicable to actions begun before January 1, 1970, to the fullest extent possible

PART 1507—AGENCY COMPLIANCE

1507.1 Compliance
1507.2 Agency Capability to Comply
1507.3 Agency Procedures

AUTHORITY: NEPA, the Environmental Quality Improvement Act of 1970, as amended (42 U.S.C. 4371 et seq.), Section 309 of the Clean Air Act, as amended (42 U.S.C. 7609), and Executive Order 11514, Protection and

Enhancement of Environmental Quality (March 5, 1970, as amended by Executive Order 11991, May 24, 1977).

§ 1507.1 COMPLIANCE

All agencies of the Federal Government shall comply with these regulations. It is the intent of these regulations to allow each agency flexibility in adapting its implementing procedures authorized by § 1507.3 to the requirements of other applicable laws.

§ 1507.2 AGENCY CAPABILITY TO COMPLY

Each agency shall be capable (in terms of personnel and other resources) of complying with the requirements enumerated below. Such compliance may include use of other's resources, but the using agency shall itself have sufficient capability to evaluate what others do for it. Agencies shall:

(a) Fulfill the requirements of Sec. 102(2)(A) of the Act to utilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences and the environmental design arts in planning and in decisionmaking which may have an impact on the human environment. Agencies shall designate a person to be responsible for overall review of agency NEPA compliance.

(b) Identify methods and procedures required by Sec. 102(2)(B) to insure that presently unquantified environmental amenities and values may be given appropriate consideration.

(c) Prepare adequate environmental impact statements pursuant to Sec. 102(2)(C) and comment on statements in the areas where the agency has jurisdiction by law or special expertise or is authorized to develop and enforce environmental standards.

(d) Study, develop, and describe alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources. This requirement of Sec. 102(2)(E) extends to all such proposals, not just the more limited scope of Sec. 102(2)(C)(iii) where the discussion of alternatives is confined to impact statements.

(e) Comply with the requirements of Sec. 102(2)(H) that the agency initiate and utilize ecological information in the planning and development of resource-oriented projects.

(f) Fulfill the requirements of sections 102(2)(F), 102(2)(G), and 102(2)(I), of the Act and of Executive Order 11514, Protection and Enhancement of Environmental Quality, Sec. 2.

§ 1507.3 AGENCY PROCEDURES

(a) Not later than eight months after publication of these regulations as finally adopted in the FEDERAL REGISTER, or five months after the establishment of an agency, whichever shall come later, each agency shall as necessary adopt procedures to supplement these regulations. When the agency is a department, major subunits are encouraged (with the consent of the department) to adopt their own procedures. Such procedures shall not paraphrase these regulations. They shall confine themselves to implementing procedures. Each agency shall consult with the Council while developing its procedures and before publishing them in the FEDERAL REGISTER for comment. Agencies with similar programs should consult with each other and the Council to coordinate their procedures, especially for programs requesting similar information from applicants. The procedures shall be adopted only after an opportunity for public review and after review by the Council for conformity with the Act and these regulations. The Council shall complete its review within 30 days. Once in effect they shall be filed with the Council and made readily available to the public. Agencies are encouraged to publish explanatory guidance for these regulations and their own procedures. Agencies shall continue to review their policies and procedures and in consultation with the Council

to revise them as necessary to ensure full compliance with the purposes and provisions of the Act.

(b) Agency procedures shall comply with these regulations except where compliance would be inconsistent with statutory requirements and shall include:

(1) Those procedures required by §§ 1501.2(d), 1502.9(c)(3), 1505.1, 1506.6(e), and 1508.4.

(2) Specific criteria for and identification of those typical classes of action:

(i) Which normally do require environmental impact statements.

(ii) Which normally do not require either an environmental impact statement or an environmental assessment (categorical exclusions (§ 1508.4)).

(iii) Which normally require environmental assessments but not necessarily environmental impact statements.

(c) Agency procedures may include specific criteria for providing limited exceptions to the provisions of these regulations for classified proposals. They are proposed actions which are specifically authorized under criteria established by an Executive Order or statute to be kept secret in the interest of national defense or foreign policy and are in fact properly classified pursuant to such Executive Order or statute. Environmental assessments and environmental impact statements which address classified proposals may be safeguarded and restricted from public dissemination in accordance with agencies' own regulations applicable to classified information. These documents may be organized so that classified portions can be included as annexes, in order that the unclassified portions can be made available to the public.

(d) Agency procedures may provide for periods of time other than those presented in § 1506.10 when necessary to comply with other specific statutory requirements.

(e) Agency procedures may provide that where there is a lengthy period between the agency's decision to prepare an environmental impact statement and the time of actual preparation, the notice of intent required by § 1501.7 may be published at a reasonable time in advance of preparation of the draft statement.

PART 1508—TERMINOLOGY AND INDEX

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Authority: NEPA, the Environmental Quality Improvement Act of 1970, as amended (42 U.S.C. 4371 *et seq.*), Section 309 of the Clean Air Act, as amended (42 U.S.C. 7609), and Executive Order 11514, Protection and Enhancement of Environmental Quality (March 5, 1970, as amended by Executive Order 11991, May 24, 1977).

§ 1508.1 TERMINOLOGY

The terminology of this part shall be uniform throughout the Federal Government.

§ 1508.2 ACT

"Act" means the National Environmental Policy Act, as amended (42 U.S.C. 4321, et seq.) which is also referred to as "NEPA."

§ 1508.3 AFFECTING

"Affecting" means will or may have an effect on.

§ 1508.4 CATEGORICAL EXCLUSION

"Categorical Exclusion" means a category of actions which do not individually or cumulatively have a significant effect on the human environment and which have been found to have no such effect in procedures adopted by a Federal agency in implementation of these regulations (§ 1507.3) and for which, therefore, neither an environmental assessment nor an environmental impact statement is required. An agency may decide in its procedures or otherwise, to prepare environmental assessments for the reasons stated in § 1508.9 even though it is not required to do so. Any procedures under this section shall provide for extraordinary circumstances in which a normally excluded action may have a significant environmental effect.

§ 1508.5 COOPERATING AGENCY

"Cooperating Agency" means any Federal agency other than a lead agency which has jurisdiction by law or special expertise with respect to any environmental impact involved in a proposal (or a reasonable alternative) for legislation or other major Federal action significantly affecting the quality of the human environment. The selection and responsibilities of a cooperating agency are described in § 1501.6. A State or local agency of similar qualifications or, when the effects are on a reservation, an Indian tribe, may by agreement with the lead agency become a cooperating agency.

§ 1508.6 COUNCIL

"Council" means the Council on Environmental Quality established by Title II of the Act.

§ 1508.7 CUMULATIVE IMPACT

"Cumulative impact" is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts

can result from individually minor but collectively significant actions taking place over a period of time.

§ 1508.8 EFFECTS

"Effects" include:

(a) Direct effects, which are caused by the action and occur at the same time and place.

(b) Indirect effects, which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems.

Effects and impacts as used in these regulations are synonymous. Effects includes ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative. Effects may also include those resulting from actions which may have both beneficial and detrimental effects, even if on balance the agency believes that the effect will be beneficial.

§ 1508.9 ENVIRONMENTAL ASSESSMENT

"Environmental Assessment":

(a) Means a concise public document for which a Federal agency is responsible that serves to:

(1) Briefly provide sufficient evidence and analysis for determining whether to prepare an environmental impact statement or a finding of no significant impact.

(2) Aid an agency's compliance with the Act when no environmental impact statement is necessary.

(3) Facilitate preparation of a statement when one is necessary.

(b) Shall include brief discussions of the need for the proposal, of alternatives as required by sec. 102(2)(E), of the environmental impacts of the proposed action and alternatives, and a listing of agencies and persons consulted.

§ 1508.10 ENVIRONMENTAL DOCUMENT

"Environmental document" includes the documents specified in § 1508.9 (environmental assessment), § 1508.11 (environmental impact statement), § 1508.13 (finding of no significant impact), and § 1508.22 (notice of intent).

§ 1508.11 ENVIRONMENTAL IMPACT STATEMENT

"Environmental Impact Statement" means a detailed written statement as required by Sec. 102(2)(C) of the Act.

§ 1508.12 FEDERAL AGENCY

"Federal agency" means all agencies of the Federal Government. It does not mean the Congress, the Judiciary, or the President, including the performance of staff functions for the President in his Executive Office. It also includes for purposes of these regulations States and units of general local government and Indian tribes assuming NEPA responsibilities under section 104(h) of the Housing and Community Development Act of 1974.

§ 1508.13 FINDING OF NO SIGNIFICANT IMPACT

"Finding of No Significant Impact" means a document by a Federal agency briefly presenting the reasons why an action, not otherwise excluded (§ 1508.4), will not have a significant effect on the human environment and

for which an environmental impact statement therefore will not be prepared. It shall include the environmental assessment or a summary of it and shall note any other environmental documents related to it (§ 1501.7(a)(5)). If the assessment is included, the finding need not repeat any of the discussion in the assessment but may incorporate it by reference.

§ 1508.14 HUMAN ENVIRONMENT

"Human Environment" shall be interpreted comprehensively to include the natural and physical environmental and the relationship of people with that environment. (See the definition of "effects" (§ 1508.8).) This means that economic or social effects are not intended by themselves to require preparation of an environmental impact statement. When an environmental impact statement is prepared and economic or social and natural or physical environmental effects are interrelated, then the environmental impact statement will discuss all of these effects on the human environment.

§ 1508.15. JURISDICTION BY LAW

"Jurisdiction by law" means agency authority to approve, veto, or finance all or part of the proposal.

§ 1508.16 LEAD AGENCY

"Lead Agency" means the agency or agencies preparing or having taken primary responsibility for preparing the environmental impact statement.

§ 1508.17 LEGISLATION

"Legislation" includes a bill or legislative proposal to Congress developed by or with the significant cooperation and support of a Federal agency, but does not include requests for appropriations. The test for significant cooperation is whether the proposal is in fact predominantly that of the agency rather than another source. Drafting does not by itself constitute significant cooperation. Proposals for legislation include requests for ratification of treaties. Only the agency which has primary responsibility for the subject matter involved will prepare a legislative environmental impact statement.

§ 1508.18 MAJOR FEDERAL ACTION

"Major Federal action" includes actions with effects that may be major and which are potentially subject to Federal control and responsibility. Major reinforces but does not have a meaning independent of significantly (§ 1508.27). Actions include the circumstance where the responsible officials fail to act and that failure to act is reviewable by courts or administrative tribunals under the Administrative Procedure Act or other applicable law as agency action.

(a) Actions include new and continuing activities, including projects and programs entirely or partly financed, assisted, conducted, regulated, or approved by federal agencies; new or revised agency rules, regulations, plans, policies, or procedures; and legislative proposals (§§ 1506.8, 1508.17). Actions do not include funding assistance solely in the form of general revenue sharing funds, distributed under the State and Local Fiscal Assistance Act of 1972, 31 U.S.C. 1221 et seq., with no Federal agency control over the subsequent use of such funds. Actions do not include bringing judicial or administrative civil or criminal enforcement actions.

(b) Federal actions tend to fall within one of the following categories:

(1) Adoption of official policy, such as rules, regulations, and interpretations adopted pursuant to the Administrative Procedure Act, 5 U.S.C. 551 et seq.; treaties and international conventions or agreements; formal documents establishing an agency's policies which will result in or substantially alter agency programs.

(2) Adoption of formal plans, such as official documents prepared or approved by federal agencies which guide or prescribe alternative uses of federal resources, upon which future agency actions will be based.

(3) Adoption of programs, such as a group of concerted actions to implement a specific policy or plan; systematic and connected agency decisions allocating agency resources to implement a specific statutory program or executive directive.

(4) Approval of specific projects, such as construction or management activities located in a defined geographic area. Projects include actions approved by permit or other regulatory decision as well as federal and federally assisted activities.

§ 1508.19 MATTER

"Matter" includes for purposes of Part 1504:

(a) With respect to the Environmental Protection Agency, any proposed legislation, project, action, or regulation as those terms are used in Section 309(a) of the Clean Air Act (42 U.S.C. 7609).

(b) With respect to all other agencies, any proposed major Federal action to which section 102(2)(C) of NEPA applies.

§ 1508.20 MITIGATION

"Mitigation" includes:

(a) Avoiding the impact altogether by not taking a certain action or parts of an action.

(b) Minimizing impacts by limiting the degree or magnitude of the action and its implementation.

(c) Rectifying the impact by repairing, rehabilitating, or restoring the affected environment.

(d) Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.

(e) Compensating for the impact by replacing or providing substitute resources or environments.

§ 1508.21 NEPA PROCESS

"NEPA process" means all measures necessary for compliance with the requirements of Section 2 and Title I of NEPA.

§ 1508.22 NOTICE OF INTENT

"Notice of Intent" means a notice that an environmental impact statement will be prepared and considered. The notice shall briefly:

(a) Describe the proposed action and possible alternatives.

(b) Describe the agency's proposed scoping process including whether, when, and where any scoping meeting will be held.

(c) State the name and address of a person within the agency who can answer questions about the proposed action and the environmental impact statement.

§ 1508.23 PROPOSAL

"Proposal" exists at that stage in the development of an action when an agency subject to the Act has a goal and is actively preparing to make a decision on one or more alternative means of accomplishing that goal and the effects can be meaningfully evaluated. Preparation of an environmental impact statement on a proposal should be timed (§ 1502.5) so that the final statement may be completed in time for the statement to be included in any recommendation or report on the proposal. A proposal may exist in fact as well as by agency declaration that one exists.

§ 1508.24 REFERRING AGENCY

"Referring agency" means the federal agency which has referred any matter to the Council after a determination that the matter is unsatisfactory from the standpoint of public health or welfare or environmental quality.

§ 1508.25 SCOPE

Scope consists of the range of actions, alternatives, and impacts to be considered in an environmental impact statement. The scope of an individual statement may depend on its relationships to other statements (§§1502.20 and 1508.28). To determine the scope of environmental impact statements, agencies shall consider 3 types of actions, 3 types of alternatives, and 3 types of impacts. They include:

(a) Actions (other than unconnected single actions) which may be:

(1) Connected actions, which means that they are closely related and therefore should be discussed in the same impact statement. Actions are connected if they:

(i) Automatically trigger other actions which may require environmental impact statements.

(ii) Cannot or will not proceed unless other actions are taken previously or simultaneously.

(iii) Are interdependent parts of a larger action and depend on the larger action for their justification.

(2) Cumulative actions, which when viewed with other proposed actions have cumulatively significant impacts and should therefore be discussed in the same impact statement.

(3) Similar actions, which when viewed with other reasonably foreseeable or proposed agency actions, have similarities that provide a basis for evaluating their environmental consequences together, such as common timing or geography. An agency may wish to analyze these actions in the same impact statement. It should do so when the best way to assess adequately the combined impacts of similar actions or reasonable alternatives to such actions is to treat them in a single impact statement.

(b) Alternatives, which include: (1) No action alternative. (2) Other reasonable courses of actions. (3) Mitigation measures (not in the proposed action).

(c) Impacts, which may be: (1) Direct. (2) Indirect. (3) Cumulative.

§ 1508.26 SPECIAL EXPERTISE

"Special expertise" means statutory responsibility, agency mission, or related program experience.

§ 1508.27 SIGNIFICANTLY

"Significantly" as used in NEPA requires considerations of both context and intensity:

(a) *Context.* This means that the significance of an action must be analyzed in several contexts such as society as a whole (human, national), the affected region, the affected interests, and the locality. Significance varies with the setting of the proposed action. For instance, in the case of a site-specific action, significance would usually depend upon the effects in the locale rather than in the world as a whole. Both short- and long-term effects are relevant.

(b) *Intensity.* This refers to the severity of impact. Responsible officials must bear in mind that more than one agency may make decisions about partial aspects of a major action. The following should be considered in evaluating intensity:

(1) Impacts that may be both beneficial and adverse. A significant effect may exist even if the Federal agency believes that on balance the effect will be beneficial.

(2) The degree to which the proposed action affects public health or safety.

(3) Unique characteristics of the geographic area such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas.

(4) The degree to which the effects on the quality of the human environment are likely to be highly controversial.

(5) The degree to which the possible effects on the human environment are highly uncertain or involve unique or unknown risks.

(6) The degree to which the action may establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration.

(7) Whether the action is related to other actions with individually insignificant but cumulatively significant impacts. Significance exists if it is reasonable to anticipate a cumulatively significant impact on the environment. Significance cannot be avoided by terming an action temporary or by breaking it down into small component parts.

(8) The degree to which the action may adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the National Register of Historic Places or may cause loss or destruction of significant scientific, cultural, or historical resources.

(9) The degree to which the action may adversely affect an endangered or threatened species or its habitat that has been determined to be critical under the Endangered Species Act of 1973.

(10) Whether the action threatens a violation of Federal, State, or local law or requirements imposed for the protection of the environment.

§ 1508.28 TIERING

"Tiering" refers to the coverage of general matters in broader environmental impact statements (such as national program or policy statements) with subsequent narrower statements or environmental analyses (such as regional or basinwide program statements or ultimately site-specific statements) incorporating by reference the general discussions and concentrating solely on the issues specific to the statement subsequently prepared. Tiering is appropriate when the sequence of statements or analyses is:

(a) From a program, plan, or policy environmental impact statement to a program, plan, or policy statement or analysis of lesser scope or to a site-specific statement or analysis.

(b) From an environmental impact statement on a specific action at an early stage (such as need and site selection) to a supplement (which is preferred) or a subsequent statement or analysis at a later stage (such as environmental mitigation). Tiering in such cases is appropriate when it helps the lead agency to focus on the issues which are ripe for decision and exclude from consideration issues already decided or not yet ripe.

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APPENDIX G

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* U. S. GOVERNMENT PRINTING OFFICE : 1980 299-219/6804

1988 APR 07

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